Energy, Mines and Resources Canada
Énergie, Mines et Ressources Canada

Canada

Cat. No. M91-11/6-3-1989E

ISBN 0-662-16789-9

March 1988

Published by the authority of the Minister of Energy, Mines and Resources, Government of Canada

For additional copies write to:

Program Delivery and Marketing Division Distribution
Energy, Mines and Resources Canada
Ottawa, Ontario
K1A OE4

Printed in Canada

ACKNOWLEDGEMENTS

The successful completion of this research project and the production of this report would not have been possible without the technical comments and opinions of those listed below. The conclusions and opinions expressed in this report are those of the authors, and do not necessarily reflect the views of these individuals:

Energy, Mines and Resources Canada acknowledges their contribution with thanks.

Judy Colpitts, Ashton and Associates
Gustav O.P. Handegord, Trow Inc.
Madeleine Rousseau, Institute for Research in Construction
Jim White, Canada Mortgage and Housing Corporation
A. Grant Wilson, Consultant

THE MAPP: A MOISTURE ASSESSMENT AND PRESCRIPTIVE PROCEDURE

Chapter 5

of the report

AVOIDING MOISTURE PROBLEMS

WHEN RETROFITTING CANADIAN HOUSES

TO CONSERVE ENERGY

Report for Energy, Mines and Resources Canada

by

Scanada Consultants Limited

with A.T. Hansen
and Provincial Consultants Limited, St. John's
SAR Engineering, Vancouver
Marshall Macklin Monaghan Limited, Toronto

Project OSQ85-00246

Ottawa, 31 March 1988

While Chapter 5 completes the report, it has been prepared and paged as a "stand-alone" document on the MAPP and its use.

TABLE OF CONTENTS

CHAPTER 5

THE MAPP: A MOISTURE ASSESSMENT AND PRESCRIPTIVE PROCEDURE

A. Introduction

The prevailing relative humidity in houses (RH) is determined by the rate of moisture generation within the house and the rate at which it is carried away as the inside air is replaced by outside air. The relative humidity level is an indication of the potential risk of moisture problems that may occur in winter. The higher the RH, the greater the risk that problems will occur.

With one or two exceptions, energy conservation measures do in fact encourage higher humidities by reducing overall air flow through the house: by airtightening, by using the furnace less, or through the "flueless" use of electric heating or high efficiency oil and gas furnaces. The latter effect - doing without an active flue - can be doubly harmful in that it results in more positive pressure to push indoor air into the walls and roof spaces, at the same time as it reduces overall air change and thus loads the indoor air with more moisture.

Many houses undergoing retrofit for energy conservation have a substantial margin of safety, if only by being air-leaky and therefore low in humidity, so that condensation problems do not generally follow most energy-conserving retrofit work. Sometimes they do, however, and to a serious extent, particularly in some regions. As energy-conserving upgrading of houses becomes more extensive the tendency toward moisture problems becomes worse in all regions.

The tendency is assessable, the point of significant trouble is roughly predictable, and the problems are then avoidable or correctable. That is the purpose of the tool developed in this study: the MAPP, or moisture assessment-prescriptive procedure. The MAPP allows a house to be assessed firstly "as is" (and helps suggest remedies for existing moisture problems), and then allows prediction of the increased tendency toward moisture problems, and guidance on just how to prevent them, if energy-conserving retrofits are done.

(This chapter is intended to be usable by itself - a "stand alone" summation of the MAPP - which has required some repetition of material from the development work covered in earlier chapters.)

B. Basic outline of the MAPP routines

This section offers a brief introduction or preview of the sequence of the analysis that is built into the Moisture Assessment-Prescriptive Procedure. Review of the following should be helpful in using the MAPP tools and steps that are presented fully in the next sections.

1. The MAPP routines

Two levels of MAPPing are available to handle almost any house and retrofit situation.

- The first, the MAPP Pass, can very quickly screen houses and "pass" many of them, indicating they operate at low humidity and are therefore safe for considerable energy retrofit with no need for detailed MAPPing, or for the airtightness testing generally required in that or other detailed assessments. The MAPP Pass is set out in Section C.
- The second level, the Detailed MAPP, is useful for those tighter, potentially more humid houses which do not "pass" the MAPP Pass: where the safety margin is less generous or clear, or where even more energy retrofit is contemplated. It's also particularly useful as a trouble-shooting guide where the house is already plagued with moisture problems. The Detailed MAPP is set out in Section D.

N.B. Neither the MAPP PASS nor the Detailed MAPP can be considered to be completed without following as well the further section, Section E, "Ensuring that other points are considered carefully".

2. Main steps in following the Detailed MAPP routine

The following list shows the sequence of using the MAPP. The steps are described fully, with forms and charts, in Section D.

2.1 Choose the appropriate regional MAPP set.

2.2 Gather the basic data needed to follow the MAPP.

Essentially all of the following is done on a single chart, the "One-Page MAPP", provided in the MAPP sets .

2.3 Assess the existing "moisture stress" condition of the house:

i) assess air flow (natural ventilation) for midwinter conditions

- include flow through flues where appropriate

ii) assess the moisture generation rate within the house

- due to occupants

- include generation from below grade (from the surrounding soil)

iii) estimate the midwinter average RH: the "product"of i) and ii)

iv) check and adjust the estimated RH against the "recollected" actual midwinter RH. This step checks the assessments of air flow and moisture.

v) compare against the "cautionary" and "critical" RH levels and thus determine the existing "moisture stress" condition: Does the house have a large safety margin, or small, or none?

The cautionary RH is the midwinter level calculated to leave just a slim margin of safety, avoiding excessive condensation on cool indoor surfaces (particularly double glazed windows) and generally, if certain "traps" are avoided, within insulated wall and roof spaces as well. The house could be operated at such a level right through the midwinter period and encounter nothing more than nuisance amounts of condensation now and then, but some caution should be exercized. (Of course, lower RH would ensure essentially no condensation anywhere, but low RH may not be broadly acceptable and, in any case, may indicate that energy-conserving opportunity has not been fully exploited.)

The critical RH is the midwinter level calculated to represent the limit of safety: operating the house above this level for much of the time in winter will result in excessive condensation on double glazed windows and other cool surfaces, and also within insulated wall and roof spaces in too many circumstances. The risk of damage becomes too high.

While they cannot be set as precise limits, the cautionary and critical levels have been defined roughly from the field studies, and built into the One-Page MAPPs for various winter climates. The main job of the MAPP routines is to help ensure that the indoor RH can be kept under the critical level enough of the time in winter, even if the house is substantially retrofitted to conserve energy.

2.4 Predict the moisture stress condition if energy conserving retrofit work were done.

i) Assess how much the retrofit work will affect air flow (natural ventilation) in midwinter by airtightening effects an/or by reducing or eliminating flue flows. (Energy conserving retrofit by itself rarely affects the moisture generation rate; just the air flow rate.)

ii) Retrace the remaining steps on the One-Page MAPP, just as in 2.3.

iii) If required - i.e., if the retrofitted house will likely be "moisture stressed" well over the cautionary RH level, or indeed over the critical RH - then "Preventive Measures" should be selected and the house tried again - on the One-Page MAPP - as follows.

2.5 Select Preventive Measures and try the house again on the One-Page MAPP; adjust as needed.

i) Select Preventive Measures, generally choosing to reduce moisture generation (or directly remove it) rather than increasing air flow (which increases energy usage). Apply them to the house, on paper....

ii) Re-enter the One-Page MAPP with all adjustments.

iii) Estimate the midwinter RH, compare against the cautionary or critical levels, and adjust by applying more or less Preventive Measures to keep the predicted Midwinter RH below the critical level.

(Considering the foregoing steps, it can be seen that "troubleshooting" a house with existing moisture problems can be aided by the MAPP even more readily than the more subtle job of predicting and avoiding moisture problems in advance of energy retrofit work. In carrying out 2.3, the characteristics or earlier measures that caused the problem become obvious, and therefore the tailored solutions become obvious - with no need for costly over-reaction - and can be tried on the One-Page MAPP.)

2.6 Finally - especially if the house is expected to operate in the cautionary zone - consideration of further points of moisture control should be recommended...Section E. It will be seen that these relate primarily to control of air leaks and water leaks, and avoidance of moisture entrapment, both above grade and below.

Next follows the details on all of the above, beginning with the shortcut approach - the MAPP Pass.

C. The MAPP Pass

The airleakiness of a house may be judged very roughly from certain characteristics, as was explored in the study. Whole classes of houses are found to lie within broad ranges of leakiness, so an approximation of the airleakiness for a given house in a given class of construction/finish can be judged from its size and a few key features. From that, its range of winter air change rate can be estimated. If a rough judgement of moisture sources is also possible, then the MAPP method can suggest the approximate indoor humidity that may prevail in average midwinter conditions.

There is very little precision offered in such a rough assessment, of course, in that there is no airtightness test or full accounting of factors. However, if the crude assessment suggests that a given house will "run" rather dry in winter, then it may be safe to judge that it can accept considerable energy retrofit without being driven into moisture trouble. Its safety margin probably being generous, airtightness testing and detailed MAPPing may not be considered necessary before retrofitting.

This shortcut approach may be termed the "MAPP Pass". It can be set up by simply "pre-MAPPing" classes of houses and moisture loadings, using the study's approximations of average airleakiness and allowing for house size and features.

It must be emphasized that many houses - especially among those built within the last two decades - are much tighter than their class average and are therefore not nearly as "safe" for energy retrofit as a visual "pass" would imply. It may be argued that those with plywood or waferboard subfloor and sheathing - and certainly those with polyethylene vapour barrier - should always be assessed through the full MAPP routine.

The draft MAPP Pass as offered overleaf includes a second criterion, using the fact that window condensation patterns are normally reliable telltales of the actual level of indoor humidity. Recollection of the patterns in midwinter allows a crude confirmation of the midwinter average RH, adding somewhat more accuracy and confidence to the draft procedure. In every case, however, the householder is well advised to consider the cautionary points given in Section E, and should be advised that:

- it is wise to "monitor" the house, the winter following retrofit, to be aware of excessive window condensation or other moisture problems, and that

- the Detailed MAPP routine is available for more certain guidance in easily correcting moisture problems should they occur, or in safely retrofitting more extensively.

MAPP PASS SUMMARY

1.A. **O.K. for MAJOR* energy retrofit without use of the Detailed MAPP**

(If no Equivalent Leakage Area data available, use this column)

built before 1975, never extensively airtightened

combustion heated with active flue

NOT stucco clad, or tightly battened/ caulked panel-type clad; not poly-ethylene vap. barrier'd

concrete basement floor with few or no signs or history of winter damp areas or fall and winter flooding

double glazed windows

laundry dried outdoors or in vented clothes dryer

midwinter window condensation no worse than "bottom **edge** of glass, only on cold mornings (or somewhat worse if humidifier running)**

approx.house size (heated living area, but never counting basement area)	no kitchen or bathroom fans installed	kitchen and at least one bathroom fan installed
100 m² or greater (1100 sq. ft.)	4 occupants	5 occupants
	- or less -	
150 m² or greater (1600 sq. ft.)	6 occupants	7 occupants

or 1.B. **O.K. for MAJOR* energy retrofit without use of the Detailed MAPP**

(Tested Equivalent Leakage Area data available)

any house subject only to the following

concrete basement floor with few or no signs or history of winter damp areas or fall and winter flooding

double glazed windows

laundry dried outdoors or in vented clothes dryer

midwinter window condensation no worse than "bottom **edge** of glass, only on cold mornings (or somewhat worse if humidifier running)**

tested Equivalent Leakage Area	no kitchen or bathroom fans installed	kitchen and at least one bathroom fan installed
1600 cm^2 or greater	4 occupants	5 occupants
	- or less -	
2400 cm^2 or greater	6 occupant	7 occupants

2. **O.K. for MINOR*** energy retrofit without use of the Detailed MAPP**

- any house where midwinter window condensation is no worse than "bottom **area** of glass (up to half of window), only on cold mornings" (or somewhat worse if humidifier running)**

3. **ALWAYS** - SEAL GROSS ENVELOPE LEAKS AND AVOID ENTRAPMENT DETAILS: see Section E

* "Major energy retrofit" refers to full airtightening of walls, ceiling and basement and/or changing to flueless heating and/or any combination of measures that will probably reduce air change by 40% or 50%.

** Considering only the indoor surface of double glazed windows having drapes, curtains or blinds open and disregarding kitchens and bathrooms

*** "Minor energy retrofit" refers to most airtightening, new windows and/or siding and/or any combination of measures that will probably reduce air change by 25% or less

D. The Detailed MAPP

- For use with houses that do not "pass" the MAPP Pass, or simply where more careful trouble-shooting, comprehension or more extensive energy retrofit is desired. Even the Detailed MAPP can not offer precision or certainty, but it provides guidance on avoiding serious moisture problems. If some problems do crop up the householder can simply operate the house with a little less moisture generation, better moisture removal, or more attention to air leaks or other points as will be shown. Example usage of the Detailed MAPP routine is shown in Appendix A.

1. Choosing the appropriate regional MAPP set

Using the computer analysis developed in the study, Canada has been divided firstly into "regions" whose winter climates produce a similar average RH for a given house and occupancy, and the cautionary and critical limits are also essentially the same. Secondly, the regions have been divided further depending on location, i.e., inland, or windy coastal, which affects certain behaviour in exfiltration-condensation, spring drying and rain leakage problems. The climatic regions are described below, while MAPP sets for the main regions are given in Section F.

The user should be able to place the house in the appropriate region by reference to its title and the example municipalities listed with it. The mean January temperature is given below as a main characteristic of the climatic region, to help in placing a location. (In all the analyses, and in the following groupings, the mean temperatures are first adjusted for urban-suburban locations by adding 2°C to the meteorological records, which refer to airport or other open-area stations. The MAPPs themselves have all such factors built in, but the 2° adjustment must be made when deciding which of the climatic regions best fits a given site.)

i) Atlantic Coast
...St. John's, Grand Bank, Stephenville...Halifax, Sydney, Charlottetown, Summerside...Moncton...and other windy coastal or near-coast sites with Jan. mean temp.(with +2° adjustment) of about -2 to -6°C...use Atlantic Coast MAPP set from Section F...

ii) Atlantic Coast Mild
...Yarmouth, Sable, Digby area... and other windy coastal or near-coast sites with Jan. mean temp. (with +2° adjustment) of about 0°C...use the MAPP set from vi) but follow the Atlantic Coast considerations when carrying out the Section E assessment...

iii) Inland Mild
...Toronto, Windsor, London, Sarnia, Ste. Catherines, Niagara Falls... and also Truro,N.S.; Sackville, N.B.; Gander, Nfld...but in such latter cases some consideration of Section E's Atlantic Coast points may be appropriate... other sites with Jan. mean temp. (with +2° adjustment) of about -2°C to -6°C...

iv) Inland Medium (and some coastal areas)
...Fredericton, Edmunston...Montreal, Sherbrooke... Ottawa, Sault Ste. Marie...Calgary, Lethbridge...Prince George... and also Quebec City, Trois Rivieres...but in such latter cases some consideration of Section E's Atlantic Coast points may be appropriate...and other sites with Jan. mean temp (with +2° adjustment) of about -7 to -11°C...

v) Inland Cold
...Winnipeg and prairie locations generally...Sept. Iles, Bagotville...Goose Bay...Sudbury, Thunder Bay...Prince Albert...Whitehorse...and other sites with mean Jan. temp.(with +2° adjustment) of about -12 to -20°C...

vi) B.C.South Inland and Okanagan (and mid coast?)
...Kelowna, Kamloops, Penticton...other sites in the region with Jan. mean temp. (with +2°C adjustment) of about -3 to +1°C...Prince Rupert and area could perhaps also be dealt with in this climatic set for MAPP purposes...

vii) B.C. South Coast and South Vancouver Island
...Vancouver, South Vancouver Island...(Victoria and South Vancouver Island probably deserve a distinct MAPP set, but in any case both MAPP analysis and experience would suggest that a reasonably tight house with moderate moisture load can not be operated there with windows closed through the "winter" season...it is a special case.)

viii) Sub Arctic
...Thompson, Churchill... Baker Lake, Yellowknife, Inuvik... other centres with mean Jan.temp. (with or without adjustment) of about -21°C or colder...use the MAPP set from v), Inland Cold, but using the lower part of the cautionary and critical RH zones...

2. Gathering Basic data needed to follow MAPP in detail

Some or most of the following may be needed for a given case:

A. Information that May Be Needed to Assess Moisture Generation

(1) Number of occupants 1 2 3 4 5 6 7 8

(2) Number normally home only at night 1 2 3 4 5 6 7 8

(3) Clothes dryer yes[ ] no[ ]
(4) -vented outdoors in heating season (HS) yes[ ] no[ ]

(5) Hanging laundry to dry indoors in HS
-the odd piece or two, now and then [ ]
-a little of the washing, regularly [ ]
-most or all of the washing, regularly [ ]

(6) Kitchen fan* (disregard charcoal or other recirculating types) yes[ ] no[ ]

(7) -used in HS when cooking, boiling water or dishwashing
almost always[ ]
whenever needed to clear windows or odours[ ]
rather seldom[ ]

(8) Bathroom fan(s)* in bathroom(s) where most bathing/showering is done yes[ ] no[ ]

(9) -used in HS when bathing/showering almost always[ ]
whenever needed to clear windows[ ]
sometimes[ ]

[* Check to see that fans do not exhaust into the attic.]

(10) Humidifiers none[ ] portable[ ] on warm air[ ]

(11) -used during HS almost always[ ]
sometimes[ ]
seldom[ ]

(12) -if on warm air furnace...setting in midwinter, %RH[ ]

(13) Dehumidifiers none[ ] basement, summer-fall [ ]

(14) -if other usage and/or placement, identify... [ ]

(15) Hobbies or activities likely to give off moisture freely, and not specially vented? Identify*...

[* Examples include indoor greenhouse or hydroponic gardens, large aquariums, whirlpool baths, hairdressing salons... Not included are most arrays of house plants; or saunas, photography labs or other facilities or activities that add little moisture to the air, or only now and then.]

(16) Foundation type
mostly basement[ ]
mostly crawlspace[ ]
mixed[ ]
slab-on-grade[ ]

(17) Foundation wall
concrete[ ]
conc. block[ ]
stone, brick...[ ]

(18) Dirt floor
none[ ]
about quarter of floor* [ ]
about half of floor[ ]
most or all of floor[ ]

[* "floor" meaning whole plan area of house on ground]

(19) Dirt floor appears in winter to be
dry[ ]
damp[ ]
wet[ ]

(20) Ground cover (polyethylene [ ] or other[ ])yes[ ] no[ ]

(21) Water pools on ground cover, fall-winter yes[ ] no[ ]

(22) Water floods over considerable area of basement floor (any material or finish) in fall-winter
never or rarely[ ]
some years[ ]
often[ ]

(23) Floor drain yes[ ] no[ ]

(24) -usually open to storm/drain tile in HS yes[ ] no[ ]

(25) Water seepage through considerable area of foundation walls (liquid water) in HS yes[ ] no[ ]

(26) Areas of efflorescence, mould and/or dampness on foundation walls in HS essentially none[ ]

a few small spots[ ]
many spots and/or some large areas[ ]

(27) Temperature of basement area in HS (or most of area...)
well below 15 C [ ]
around 15 C [ ]
well above 15 C [ ]

(28) Plan area of house on ground
[m^2]
[ft^2]

B. Information Relating to Midwinter Air Change Rate (climatic data are built in to the MAPPs for the various locations)

(29) Airleakiness: ELA, standard fan depress. m^2[ ]

(30) House height: the height **above grade** (disregarding unheated attic...) is about:
one storey[ ]
or between one and two stories, eg., raised basement, or bungalow on sloped grade[ ]
two or more storeys[ ]

(31) House exposure:* First, the general "terrain" around much of the site can best be described as:
1. ocean or large lake [ ]
2. flat terrain, few if any obstructions to winds [ ]
3. rural, low bldgs. & scattered trees [ ]
4. urban, industrial or forest area [ ]
5. centre of large city with high-rise bldgs. [ ]

[* adapted from the LBL studies - Lawrence Berkeley Laboratories]

(32) House exposure: Second, the close-in "shielding" or shelter (within 2 or 3 house heights from the house) can best be described as
1. none: no close-by shelter [ ]
2. a few scattered obstructions [ ]
3. some obstructions [ ]
4. obstructions practically all around [ ]
5. large obstructions all around house...[ ]

(33) House has an active flue(s) (i.e. venting the main combustion heating device. Do not count flue from airtight wood stove or condensing or other high efficiency furnace, or from fireplace with damper normally closed) yes[ ] no[ ]

(34) House has passive flue(s) (incl. fireplace if used often or if damper left open through HS; or any flue normally open from indoors to outdoors) yes[ ] no[ ]

C. Recollections Indicating Indoor RH, Midwinter, House "As Is"

The householder's recollection of **midwinter** window condensation fits most closely to which one, or possibly two, of the following descriptions? (**Disregard** kitchen and bathroom windows and those where heavy curtains, blinds or drapes are drawn at night. Consider only condensation on the indoor surface of double glazing.)

(a) Almost all the glass is covered "always"..."most days"...Water often runs down on and over sill...The condens. persists into early spring or even later [ ]

(b) Almost all the glass is covered "often"... "every cold day"... water sometimes runs down on to sill [ ]

(c) Almost all the glass is covered only "on coldest mornings"..."on windy, cold days"...And/or bottom area of glass is covered "often"..."most mornings" [ ]

(d) Little condensation in midwinter...bottom area of glass on cold mornings [ ]

(e) "Almost none"..."bottom edge of glass only on cold mornings" [ ]

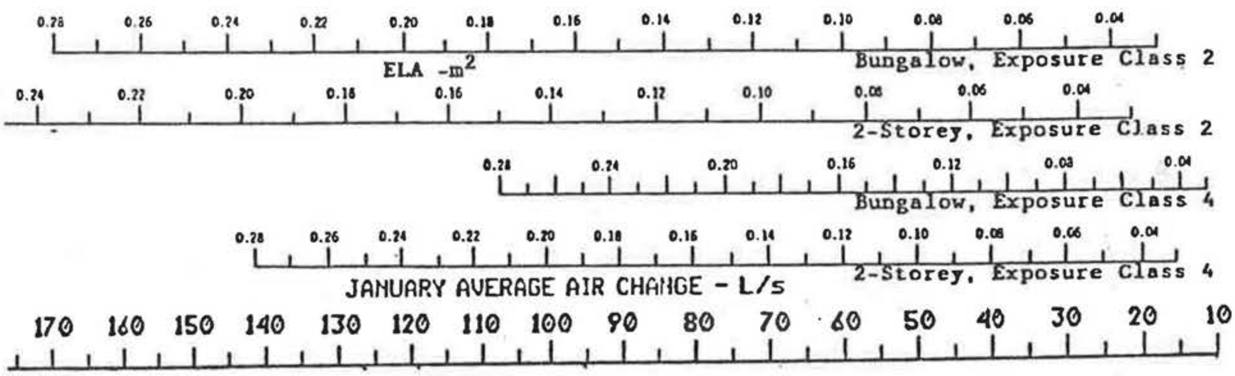
3. Assessing the existing "moisture stress' condition of the house

The average rate of air flow through the house in mid winter, acting with the average rate of moisture generation within the house, together result in an average midwinter relative humidity, RH, which is the best single indicator of moisture stress.

3.1 Assessing air flow (natural ventilation) for midwinter conditions: This is a function of wind and temperature effects (built into the One-Page MAPP for the given climatic region) and house exposure (shelter, or lack of it), height above grade, and ELA (airleakiness).

i) Determine the "exposure class" from Table 1, using the "terrain" and "shielding" characteristics noted in Section 2.

ii) From Section 2 data (Gathering Basic Data...) enter the house height, ELA and exposure class on the One-Page MAPP's top horizontal scales, and draw a vertical line downward to show the midwinter average air flow. An example of these scales is shown below. Appendix A shows example usage.



As can be seen, the top ordinate has only two exposure classes, 2 and 4. Exposure class 4 represents most modern suburban settings. Exposure class 3 may be typified by an open suburban setting, such as that of a house located at the edge of a suburb; it is easily placed by interpolating

Table 1 - RESOLVING LBL TERRAIN AND SHIELDING COMBINATIONS INTO FIVE EXPOSURE CLASSES

EXPOSURE CLASSES

TERRAIN						
1	CENTRE OF LARGE CITY WITH HIGH-RISE	4	4	4	5	5
2	URBAN, INDUSTRIAL OR FOREST AREAS	3	3	4	4	5
3	RURAL AREAS WITH LOW BLDGS. AND TREES	2	3	3	4	4
	FLAT TERRAIN FEW OBSTACLES WELL SEPARATED	2	2	2	3	4
5	OCEAN OR LAKE (5 KM OR MORE EXPANSE)	1	1	2	2	4
	↑ LBL →	NO SHIELDING	LIGHT: FEW OBSTRUC-TIONS	MODERATE: SOME OBSTRUC-TIONS	HEAVY: OBSTRUC-TIONS IN MOST DIRECTIONS	VERY HEAVY: LARGE: OBSTRUC-TIONS ALL 'ROUND
		1	2	3	4	5

LOCAL SHIELDING

(Shielding within a distance of 2 or 3 house heights.)

EXPOSURE CLASSES:
1. Extremely exposed
2. Exposed
3. Somewhat sheltered
4. Sheltered
5. Extremely sheltered

halfway between the house's ELA point on the class 2 line and its ELA point on the class 4 line.

Exposure classes 2, 3, and 4 cover almost all house situations. It is true that some houses are somewhat more exposed than class 2 (on a cliff by the sea, for example) and some are more sheltered than class 4 (a thickly tree'd suburb, or the middle of a city...or a woods), but 2, 3 and 4 cover all cases well enough.

The top ordinate of the MAPP also offers only two house heights, bungalow and two storey. The house should be assigned to whichever one best describes its height above grade. There is no need to interpolate: the effect of variation in height isn't much.

Some users may find it easier to use the ELA/Air Flow tables given as part of the regional MAPP set, and then enter the resulting air flow on the One-Page MAPP on the air flow ordinate, showing flow in litres per second (L/S). Example cases illustrating the use of the One-Page MAPP are given in Appendix A.

iii) Add air flow through flue, if any.
An active flue (serving a fuel burning appliance that is the main heat source) adds considerable air flow in average midwinter conditions:

- -about 30 L/S in most eastern coastal regions
- -about 20 L/S in most inland regions
- -about 15 L/S in milder, calmer regions such as southern B.C.

A passive flue can add almost as much - say, about 2/3 of the above. In all except very nearly airtight houses, one flue flow will add as above to another's and each will add directly to the house envelope flow as determined in ii), as a usable approximation. So the flue flow can be added and entered on the MAPP's flow ordinate (which contains a reminder to do just that). Again, the examples in Appendix A help make the point.

iv) Draw a vertical line through the MAPP from the final flow point as determined and entered on the L/S scale.

3.2 Assessing the moisture generation rate within the house.

i) Occupancy: The One-Page MAPP is provided with a split scale on the left, allowing quick assessment of moisture generation and direct placement on the vertical "MSS" ordinate ("moisture source strength", or average generation rate). On the following page, the split scale is redrawn for clarity and its usage is shown, step-by-step. (The term "Direct Removal" (DR) connotes rather direct exhausting of moisture at its source of generation; eg., a vented clothes dryer, or an effective bathroom or kitchen range fan vented outdoors.)

ii) Moisture from below grade: Use Table 2 as a guide, with the house signs and conditions as noted in Section D,2.

Soil moisture can enter basements and crawl spaces in a variety of ways and at widely different rates, depending on the nature of the soil, the effectiveness of the drainage (both surface and sub-surface), the effectiveness of the dampproofing (wall and floor), the temperature and RH of the basement air and the quality of the foundation material. It has been found by experience that where soil moisture is contributing significantly to the indoor air, it usually leaves telltale signs from which estimates of its rate of entry into the house can be made. Table 2 shows the relationship between this rate of entry and the obvious moisture signs. If there are no such signs the soil moisture contribution can be ignored to this point.

The values in Table 2 are for 100 m^2 of basement or crawl space (plan area) and may adjusted upward or downward in proportion to the measured area. (No adjustment is warranted, however, if the moisture signs are concentrated in just a minor fraction of the basement area.) This value must be added to the moisture generation due to occupancy to find the total moisture generation for the purpose of estimating RH.

iii) Add the below-grade moisture to the occupancy moisture and place the final point on the MSS scale. Draw a horizontal line from this point across the One-Page MAPP.

3.3 Estimating the midwinter average RH.

According to the One-Page MAPP, with its built-in functions of climate, and the entered judgements on air flow and moisture factors, the midwinter average RH in the existing house is approximated by the point where the vertical line of air flow crosses the horizontal line of moisture generation. Of course, the MAPP (i.e., the array of computer algorithms that form it) can only be as accurate as the judgements and rounded approximations it must work with...

3.4 Checking and adjusting the estimated RH against the "recollected" actual midwinter RH.

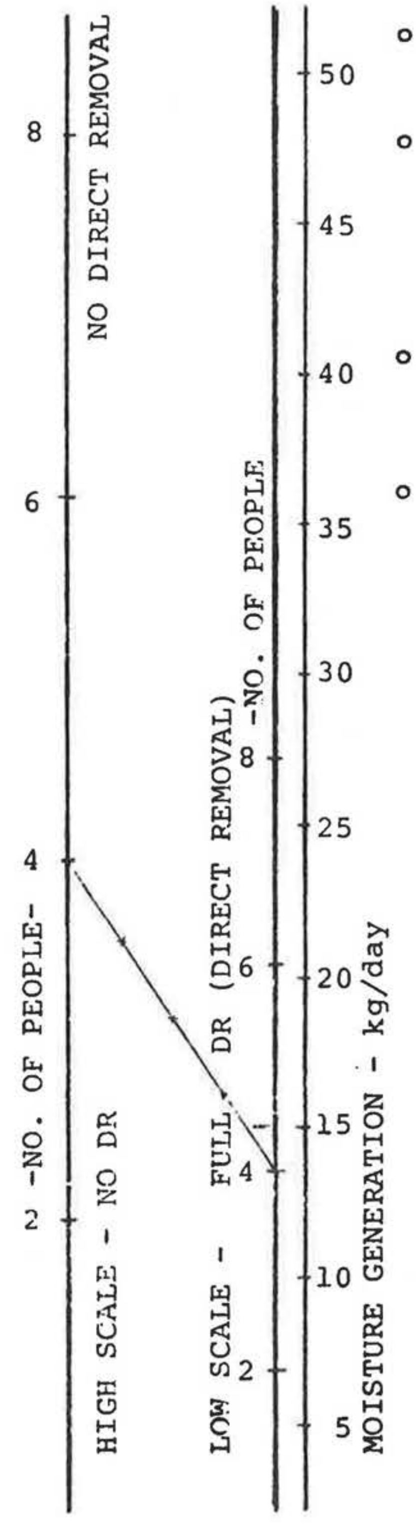


FIGURE 1 SPLIT SCALE, MOISTURE GENERATION

- Mark the number of occupants on the "No DR" scale, indicating the top of the probable range.
- Do likewise on the Full DR scale, marking the extreme bottom of the range. In Figure 1, the example of four occupants is marked. Hours at home are disregarded: overnight occupancy is all that matters at this point.
- Draw a straight line between the two marks, forming a "range line" as shown. Mark its quarter and half points.
- Judge the actual level on the range line:
  - If the clothes dryer is always vented in winter, set the level first at the point three quarters of the way down the range line.
  - However, if the clothes dryer is not vented the level should first be set at the top of the range line.
  - If both kitchen and bath are provided with fans and these are always used when cooking or bathing/showering in winter, adjust the level downward from its beginning position by an amount equal to one quarter of the length of the range line.
  - However, if there is little or no such DR, the MSS level may be left where it was first placed. If only one such fan is installed and used rigorously, or if the fans are used just "most of the time", the level may be adjusted downward, from its first position, by one eighth the length of the range line.
  - Finally, if most of the occupants are at home day and night, and/or have hobbies, work or cooking habits often generating water vapour, the level may be adjusted upward by a distance of one quarter of the range line. This last adjustment holds true even if the final position ends up above the top of the range line.

The MSS from occupancy is indicated on the MSS scale horizontally across from the final point.

Table 2 - CATEGORIZING BELOW-GRADE MOISTURE SOURCE STRENGTH* BY OBSERVABLE CHARACTERISTICS AND TELLTALES

"MILD": 10 KG/DAY/100 M^2*		"SUBSTANTIAL": 20 KG/DAY/100 M^2	"SEVERE": 30 KG/DAY/100 M^2
Unheated, cool in winter	heated, warm in winter, (15 C or higher)	heated, warm in winter, (15 C or higher)	heated, warm in winter (15 C or higher)
Any four or more of a-f, or any two or three if temp. near 15 C, or any one of g, k, l,	Any one or two of a) some infrequent flooding or water entry in late fall or winter b) open floor drain (empty trap) c) some concrete "readings" of 20 or more on moist. meter, or d) some damp spots on concrete in winter, or spots of spalling or efflorescence e) minor fraction of floor is bare earth, no v.b. cover; earth appears dry f) "musty" or mildew odour even in winter	Any three or more of a, b, (c or d) e, f, or any one or two of: g) considerable bare earth with high water table, and/or apparent dampness in winter h) considerable bare or unsealed concrete with widespread damp spots, rdgs. of 20 or higher, or spalling or efflorescence areas i) some sustained, broad water seepage in fall and/or winter, or flooding repeating in fall or winter j) some rdgs. of 20 or higher in wood against concrete below grade	All of g, h, i together, or any of k) major fraction is bare earth, wet in winter, and 15 C or warmer at surface l) considerable standing water, film or wet seepage in winter if surface probably 15 C or warmer

* If signs are less than those indicating "mild", the assumption is that below-grade moisture contribution is nil.

This step provides a check on the assessments of air flow and moisture, adjusts the latter if necessary, and thus offers a fairly reliable starting point for predicting the effects of energy retrofit - or of "trouble-shooting" and correcting the house as it is, if it is a problem case.

i) From the householder's recollection of midwinter window condensation without humidification (in Section 2) find the approximate actual midwinter RH from Table 3. Appendix A's examples are helpful in all of this.

ii) If the recollected RH is less than that estimated on the One-Page MAPP (3.3) it can be ignored, but if it is higher, the calculated RH level should be adjusted straight upward to a point halfway between the two RH values. This implies a correction to the moisture generation estimate only.

However, if a powerful drum-type humidifier has been in use in prior winters, the recollected window consensation does not serve as a check on the house's actual performance and no adjustment should be made.

3.5 Comparing against the cautionary and critical RH levels:
If the predicted RH is well below the cautionary line, the house is far from "moisture stressed" and should be ready indeed for energy-conserving retrofit, referring to Section 4. If it is in the cautionary zone, it can still accept such retrofit but only with some consideration of preventive measures, Section 4...If it is indeed in the critical zone, then it's a "troubleshooting" case: Section 4's preventive measures can be brought forward as remedial measures and tried out on the One-Page MAPP (as in Section 5.)

4. Predicting the moisture stress condition as if energy-conserving retrofit work were done

i) "Energy Measures" tend to reduce air flow but not moisture generation. The effect of selected measures can be approximated from Table 4 and a correction applied to the L/S scale on the One-Page MAPP. Do not ignore flue effects.

ii) Retrace the remaining steps just as in Section 3, above.

iii) If required - i.e., if the retrofitted house will likely operate well over the cautionary RH or indeed over the critical RH - select Preventive Measures as follows.

TABLE 3

CHECKING MIDWINTER AVERAGE RH FROM RECOLLECTED EXTENT OF WINDOW CONDENSATION

Excluding kitchens, bathrooms and basements, windows in one or more rooms show one of the following patterns of condensation on the indoor surface of the glass in January and February, when drapes, curtains or blinds are open and the room temperature is about 20°C. (If temperature is lower overnight and/or drapes, curtains or blinds are closed overnight, the following patterns indicate their respective RH's if the condensation persists well into or through the day after temperature is raised and obstructions opened). Consider only double glazed windows (except in Vancouver category).

Pattern recollected	Midwinter Average RH implied by that pattern					
	St.John's Atlantic Coast	Ottawa Inland Med.	Toronto Inland Mild	Winnipeg Inland Cold	Vancouver B.C. S. Coast	Vancouver Single Glazed
	---or higher---					
a) Almost all the glass is covered "always"..."most days"....Water often runs down on and over sill...The condens. persists into early spring or even later	60%	54	59	44	70	53
b) Almost all the glass is covered "often"... "every cold day"... water sometimes runs down on to sill	55%	48	54	39	66	46
c) Almost all the glass is covered only "on coldest mornings"..."on windy, cold days"...And/or bottom area of glass is covered "often"..."most mornings"	50%	42	50	33	62	44
d) Little condensation is midwinter..bottom area of glass on cold mornings	45%	37	44	26	56	37
e) '"Almost none".."bottom edge of glass only on cold mornings"	40%	33	40	23	50	33
	---or lower---					

TABLE 3: ENERGY MEASURES: ESTIMATING AIRTIGHTNESS/AIR FLOW ADJUSTMENTS

COMPONENT AND RETROFIT ENERGY MEASURE	RELATIVE AIRTIGHTENING
WALLS	
a) Interior sealing incl. baseboards, trim, or	10%
b) Fully insulating cavity with cellulose fibre, or	10%
c) Applying exterior insulation with "wrap" air barrier or equiv., sealed to windows and doors, or	20%
d)...a) or b), plus c)	25%
Notes: - If house is already stuccoed, or of airtight construction, the above measures may not help appreciably. If house already has tight cladding (caulked painted clapboard, panel plywood, panel hardboard...) c) may not airtighten further and effect of a) or b) may be halved.	
WINDOWS AND DOORS (Sealing of interior trim is included under walls)	
a) Sealing and/or full weatherstripping of openings, or	10%
b) Installation of tight new windows; and tight new doors or weatherstrip	10%
BASEMENT	
a) Full sealing of basement	10%
ROOF/CEILING	
a) Sealing of fixtures, stacks, flues, all gross leaks, or	10%
b) Insulating attic with cellulose fibre, or equivalent (mineral wool if polyethylene placed carefully under), with fixtures, stacks and flues sealed.	10%
HEATING SYSTEM	**DIRECT REDUCTION IN AIR FLOW**
a) Changing from active flue to flueless heating or near equivalent	
- Windy Atlantic coast	30 L/S
- Inland Canada generally	20 L/S
- Mild, low-wind areas	15 L/S

5. Selecting preventive measures and trying the house again on the One-Page MAPP

The split-scale figuring for the given house (Figure 1) has already suggested why the moisture generation rate is as high as it is. It is usually easy to suggest "preventive measures" that reduce the generation by controlling the sources or using "Direct Removal" fans at the source. The effect can be assessed on the Figure 1 scales. It is always best to try reducing moisture (for example, recommend a ground cover on a crawl space floor, or consistent use of bathroom and kitchen fans...) since that consumes little or no extra energy.

(Proper grading can be one means of reducing basement moisture sources. Where any steps are suggested to reduce basement sources, it may be safe to judge that the reduction will be only 50% of the source strength which is set out in Table 2. Concerning Table 2, the descriptions of moisture signs are based on observations made on a limited number of houses during field studies, and should not be considered as being the sole indicators of significant sub-grade moisture contributions. It has been postulated that moisture can move into basements through what may appear as dry soil, or through pores and cracks in the basement wall and floor, by means of air currents through subsurface moist soil. This study, however, yielded no assessment of such infiltration in isolation from the apparent effects of evaporation alone. Where general moisture signs throughout the house indicate that the rate of moisture generation is higher than average, the contribution of moisture from such "soil gas" should be considered a possibility. At the least, the floor drains should be sealed against infiltrating air where possible.)

If direct moisture reduction is not going to be enough, some boost in overall air flow might be needed. Where adding passive flues to achieve this, air flow values of say 2/3 those of active flues may be used: about 20, 15 or 10 L/S in windy coastal, inland or mild inland regions respectively. Where the moisture problem is in the basement, inlets to passive flues should best be located there to remove the moisture at source.

It should be kept in mind that, to be effective, exhaust fans should be operated for a period after the moisture generating activities have ceased in order to clear the room of residual excess moisture. Fan selection and installation should ensure reasonable quality and ducting for sufficient capacity.

Where it is thought that the moisture level cannot be sufficiently reduced by normal operation of exhaust fans or passive flues, it may be necessary to install a 2-speed fan to operate continuously at the lower speed to provide additional capacity; or the fan may be operated automatically with a humidistat.

E. Ensuring that other points are considered carefully

- A checklist -

This section completes the Detailed MAPP, and is also suggested as a follow-through even where houses have passed the MAPP Pass routine and detailed assessment is not warranted. Although the MAPP will have helped to ensure that humidity can be kept under reasonable control, householders tend to want to run the house near the cautionary or critical level and so the points below warrant consideration. All contractors will not want to offer or conduct these inspections and corrections - especially where they are involved in just minor retrofits - but it is helpful and wise to make the householder aware of the checklist and of the opportunity to further minimize risks with just a little more forethought.

All Regions except where noted:

1. Find and plug visible gross leaks into exterior walls through the interior finish and from the basement.

   - Normal construction joints and cracks, electrical cover plates, etc. are not considered gross leaks.
   - Any hole or gap big enough to poke a finger through is clearly a gross leak into a stud space, and one of say four times that size is a gross leak into an attic...
   - Bathtubs on board subfloors and abutting exterior walls often present gross paths from the basement up into the wall space (see below, 7).
   - Warm air supply ducts having boots or registers leaking through or past the interior finish often act as gross leaks.
   - Other common points are the junctions between exhaust fan housings and interior wall finish, around recessed medicine cabinets, radiator housings, and at pipe penetrations through walls under sinks...
   - The basement should be inspected around the perimeter for any obvious openings into the exterior stud space above. Such leakage paths could include oversized holes for electrical wiring, pipe penetrations and open stud spaces (where non-firestopped balloon frame construction is used). Such larger spaces must be blocked and then caulked, or tightly stuffed with mineral wool to prevent air currents from carrying moist basement air into the stud cavities (and up into the attic).

2. Avoid entrapment of moisture in exterior walls.

   - Remove asphalt composition sidings before retro-insulating wall cavities, especially if there are signs of wall moisture problems. Generally it is wise to remove such sidings in any house facing extensive energy retrofit. (Where older houses have very little rotted sheathing under such cladding, it may well be that they have been "run" at very low humidity until this point.)

     [**Atlantic Coast:** Recommend removal of asphalt composition sidings in all cases, and recommend replacement with breather-type sheathing paper and furring (vented top and bottom) under any new siding. Where existing siding is painted wood clapboard, recommend forcing open every second lap (about 2mm) with permanent wedges, especially if cavity fill insulation is to be added. Where the walls show any signs of moisture problems, recommend <u>against</u> cavity fill and <u>for</u> external insulation as per 3.]

3. Recommend external wall insulation especially if a new siding job is needed. If the external insulation and outer air barrier are permeable types, it is not necessary to require a minimum added R value to control condensation. If, however, the external insulation is impermeable, recommend an R value at least equal to that of the existing wall (to keep the inner face of the impermeable insulation above the dew point of the indoor air through all but the coldest days of winter).

4. Find and plug gross leaks into the roof space through the ceiling plane.

     [**Inland Cold and Sub Arctic:** Recommend sealing even the finer leaks such as along partition tops.]

   - Penetrations of plumbing stacks, vent pipes, chimneys and gas vents often present gross leaks. (These should be appropriately sealed to prevent moist air being carried into the attic. Although large holes can be plugged using tightly stuffed mineral wool, in the case of masonry chimneys this can raise the surface temperature of adjacent wood if too great a depth of mineral wool is used since this space is designed to dissipate heat through convection currents).
   - When enclosed in partitions, plumbing stacks may be sealed where they penetrate the floor above the

basement. (If the gap around the pipe is large, it may be sealed by stuffing mineral wool tightly around the pipe to restrict any air flow.)

- Kitchen and bathroom exhaust fans must exhaust outdoors, not into the attic. The ducts through the attic must have air tight joints, preferably taped.

5. Recommend adding attic ventilation wherever moisture problems are evident, or where the attic is to be retro-insulated, or the house is to be operated near the cautionary or critical levels of RH, with **only** the following regional exceptions:

   [**Atlantic Coast** and other regions with strong, sustained winter and spring winds: venting of attics is often not necessary if the gross ceiling leaks have been plugged: the attic is vented more than adequately by the wind effects.]

   [**Inland Cold, Sub Arctic** and other regions or localities where dry drifting snow is common: attic venting is often not practicable and should generally be avoided. But note the previous emphasis on sealing even the finer leaks through the ceiling plane.]

   In all cases it is wise to advise the householder to check the attic in early spring for excessive moisture or mould, and to place emphasis on better sealing if needed - and extra venting only if the sealing does not do the job.

6. Flat roofs and cathedral ceilings can NOT be cavity retroinsulated with confidence, especially where the upgraded house is to be operated near the cautionary or critical levels of RH. Insulation can be added more safely above the existing roofing or below the ceiling. Both require expert advice.

7. Recommend special attention to **indoor "trouble areas"**.

   While the MAPP routines help ensure that the house as a whole will not run above the cautionary or critical RH, upgrading the house usually does boost RH and raises the likelihood of moisture problems in those rooms which often exceed the house average RH.

   - **Kitchens, bathrooms** and perhaps **laundry areas** may encounter excessive condensation on windows and cold spots, with attendant mould and deterioration. Exhaust fans or window opening habits may need emphasis even though the house is well controlled overall.

- **Bedrooms** may also experience condensation problems if temperatures are lowered too much at night. Venting may be needed, or the temperature set-back may be made less drastic.

The bathroom area should be inspected for signs of water leakage or other moisture problems. Paint peeling of the exterior surface of an exterior bathroom wall, or water stains in the room or space beneath the bathroom can indicate a local moisture problem that may be due to any one of a number of causes including:

- accidental water spills from the bathroom fixtures (or from plumbing leaks) that run beneath the bath tub and eventually enter the stud spaces.

- leakage through the tile surrounding a shower area may saturate the substrate; or water may leak into the stud spaces through discontinuities in the wall finish such as around recessed soap dishes or the junction between the bath tub and the wall tile. (This is particularly important where the tile has been pointed with porous mortar, or if the wallboard has not been effectively treated to resist water.)

The too-common practice of installing the bath tub before the wall finish is installed (or even before it is insulated and protected by a vapour barrier) makes this portion of the wall particularly vulnerable to condensation problems. Moist air from the storey beneath the bathroom can find its way through the floors (due to holes for plumbing or cracks between board subfloors) and thence into the stud spaces behind the bath tub. Plywood or waferboard subfloors can often be sealed by caulking around pipe penetrations. Board subfloors are difficult to seal for obvious reasons. Some more serious problems may only be correctable by removing the siding and sheathing in order to seal the vapour barrier, or the tub may have to be removed to make the necessary corrections. In some cases, however, large air leakage paths may be plugged by stuffing them tightly with insulation or sealing with polyurethane foam. In other cases it is easier to lower the RH, which (along with flue action that depressurizes and induces infiltration rather than exfiltration) is the reason that very many older houses have lasted so well.

8. Retrofit of basements and crawlspaces requires special care.

Below-grade moisture entry was addressed in the detailed MAPP steps, concerning the recognition and limiting of moisture entry to help control indoor RH in the whole house. While most energy-conserving retrofit of basements tends to assist in that regard, the retrofit components themselves can deteriorate due to entrapment of the incoming moisture. It is important to inspect for the telltale signs and conditions as noted before, and to recommend accordingly:

- Where telltales and MAPP analysis indicate little or no incoming moisture, or just "mild" sources, basement walls may be insulated safely following the approach cited in the National Building Code of Canada, Part 9, Subsection 9.13.5.3, NRC 23174, Ottawa 1985.
- However, where "substantial" and especially "severe" incoming moisture is indicated, the matters of surface drainage and below-grade waterproofing need competent correction before interior insulation and finishing is undertaken.

  [Perhaps particularly on both the **Pacific and Atlantic Coasts**, energy-retrofitting and finishing basements as living space may often require special consideration and re-thinking because of water problems.]

Crawl spaces appear particularly prone to moisture entry. The National Building Code Approach, cited above for basement walls, should be suitable for crawl space walls under most conditions given that untreated wood and all fibre types of insulation are kept 100 mm or so off the floor. A full ground cover of polyethylene film is always desirable, with provisions for preventing pooling of water atop the cover.

9. Recommend consideration of other points of water entry.

Although most of the following points are not caused by or directly associated with energy conserving retrofit, they merit consideration always, and perhaps especially where retrofit may tend to reduce drying action. (Where the existing house may have been accommodating some small leaks or seepages for years, harmlessly, the retrofitted house may face excessive accumulations and damage if they continue). A reminder of common trouble points would include:

- valleys, flashings, crickets, gutters, eaves drips
- flat roofs and low slope roofs generally
- window heads, window sills (especially horizontal slider configurations) and doors
- backsplash areas at intersecting roofs, decks, steps, driveways
- grading, window wells
- plumbing leaks

Windows with excessive air leakage can permit large quantities of indoor moisture to be carried into the space between double glazing, where it may condense on the colder outer surface. This eventually melts and may leak into the wall space beneath the window or cause premature deterioration of the window frame. Horizontal slider windows are particularly susceptible to this problem due to the sill details. Weatherstripping or taping the inner sash in winter may be recommended in such cases to reduce the problem.

[Particularly in **windy coastal areas:**]

Water entrapment in wall spaces beneath windows from rain leakage past the sill members can occur most commonly in areas subject to frequent wind driven rain. (These problems may be mistaken for those related to severe condensation and wrongly blamed on the retrofit measures, or vice versa.) The effect of such moisture entrapment may show up as paint failure on the exterior or interior and (even more serious) decay of the sheathing or studs, particularly in areas with prolonged poor drying conditions.

10. Tightening houses increases the need for consideration of **air quality and combustion safety.** While both are outside the province of this study, the MAPP does deal with air flow and that affects much more than moisture control.

    The predicted air flow under mean January conditions may be used in considering air quality. For example, the current ASHRAE recommendation of 15 cfm (7.1 L/s) per person could be taken as a recommended minimium air flow, on average, through the heating season. (Windows and doors are more apt to be opened as needed in other seasons.) Clearly, if the MAPP-predicted January air flow is nearing that minimum, it is wise to recommend stronger consideration of passive or mechanical venting even if moisture control does not appear to warrant it.

    In addition, a combustion safety check should be recommended where the house air flow may be reduced to such a level or lower...strongly recommended if there is a fireplace or other strong exhaust competing for air with a gas appliance of the normally aspirated type.

F. Sets of regional MAPPs and supporting tables

The following sets cover the climatic regions of populated Canada as introduced in Section D. In addition to the main tool, the One-Page MAPP, the sets include ELA-air flow tables and an air flow-moisture generation-RH chart for use with the tables. The latter approach may be preferred by some to using the One-Page MAPP, and the chart covers a wider range of house airleakiness.

The sets are presented in the order listed below. The cities on which the regions are "centered", and the sets are built, are also listed. In section D,1 other example cities are listed as well, and information on how to place practically any location in its most appropriate climatic region.

1) Atlantic Coast — St. John's

   (Atlantic Coast mild...Yarmouth region... use the BC South Inland set, but follow the Atlantic Coast considerations noted in Section E, "other points"...)

2) Inland Mild — Toronto

3) Inland Medium — Ottawa

4) Inland Cold — Winnipeg

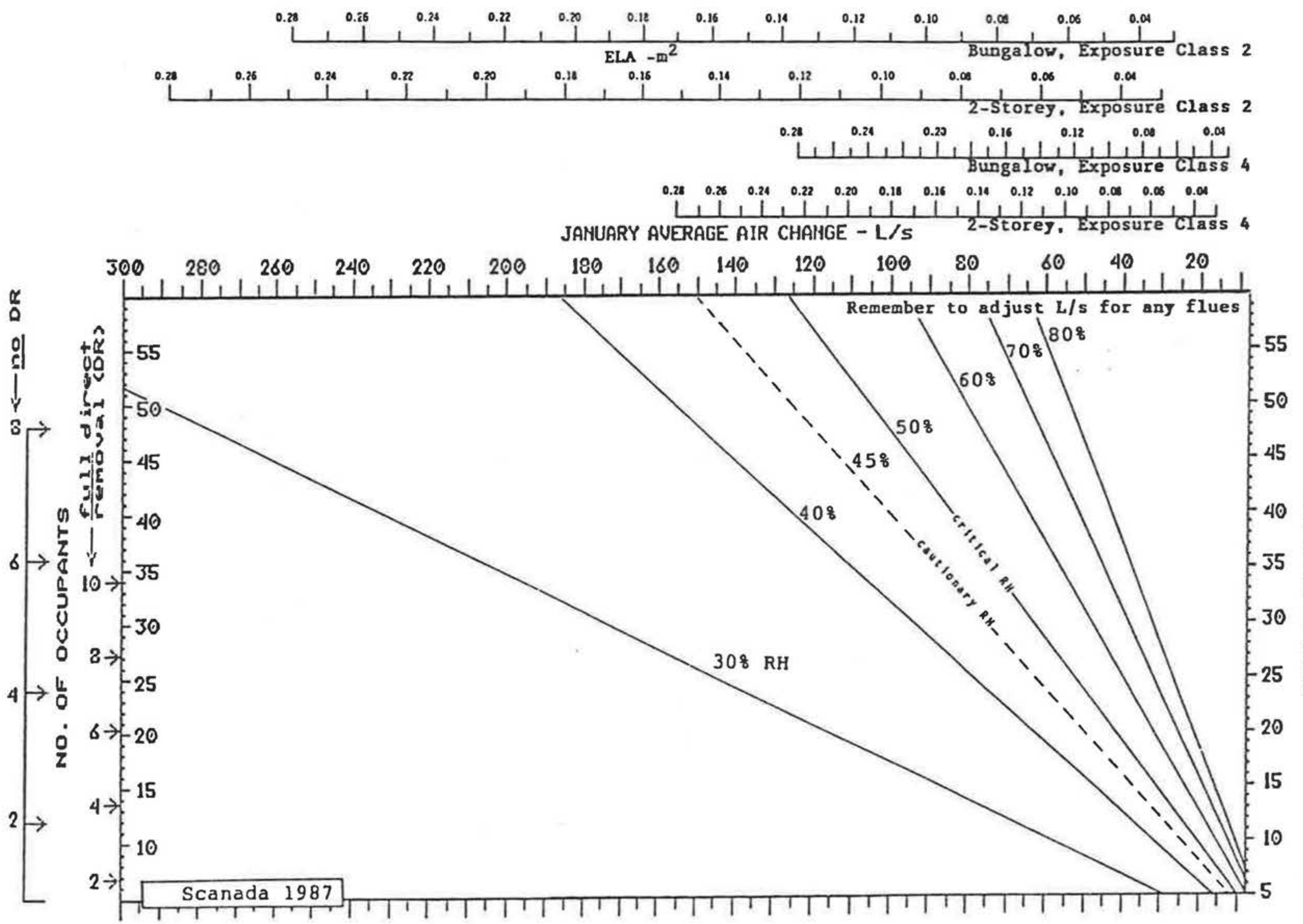
   (Sub Arctic...Use the Inland Cold set, but with attention to the sub-Arctic lines of cautionary and critical RH...)

5) BC South Inland and Okanagan — Kelowna

   (and BC mid coast as well?)

6) BC South Coast and South Vancouver Island — Vancouver

1. Atlantic Coast (St. John's): One-Page MAPP



THE ONE-PAGE MAPP, ST. JOHN'S, NFLD

1a) Atlantic Coast (St. John's): ELA/Air Flow

EXPOSURE CLASS 1

HEIGHT ABOVE GRADE(m)	2.6	BUNGALOW 3.0	3.4	RAISED BUNGALOW 3.8	4.2	4.6	5.0	5.4	2 STOREY 5.6	5.8	6.2	2-1/2 STOREY 6.8
ELA(m^2)						FLOW (L/s)						
0.03	41	42	43	43	44	44	45	45	45	45	46	46
0.04	55	56	57	57	58	59	59	60	60	61	61	62
0.05	69	70	71	72	73	73	74	75	75	76	76	77
0.06	82	84	85	86	87	88	89	90	90	91	92	93
0.07	96	98	99	101	102	103	104	105	105	106	107	108
0.08	110	112	113	115	116	118	119	120	120	121	122	124
0.09	124	126	128	129	131	132	134	135	136	136	137	139
0.10	137	140	142	144	145	147	148	150	151	151	153	154
0.11	151	154	156	158	160	162	163	165	166	166	168	170
0.12	165	168	170	172	174	176	178	180	181	182	183	185
0.13	179	181	184	187	189	191	193	195	196	197	198	201
0.14	192	195	198	201	203	206	208	210	211	212	214	216
0.15	206	209	213	215	218	220	223	225	226	227	229	232
0.16	220	223	227	230	233	235	238	240	241	242	244	247
0.17	233	237	241	244	247	250	252	255	256	257	259	263
0.18	247	251	255	258	262	265	267	270	271	272	275	278
0.19	261	265	269	273	276	279	282	285	286	287	290	293
0.20	275	279	283	287	291	294	297	300	301	303	305	309
0.21	288	293	298	302	305	309	312	315	316	318	320	324
0.22	302	307	312	316	320	323	327	330	331	333	336	340
0.23	316	321	326	330	334	338	341	345	346	348	351	355
0.24	330	335	340	345	349	353	356	360	361	363	366	371
0.25	343	349	354	359	363	367	371	375	377	378	381	386
0.26	357	363	368	373	378	382	386	390	392	393	397	402
0.27	371	377	383	388	392	397	401	405	407	408	412	417

EXPOSURE CLASS 2

HEIGHT ABOVE GRADE(m)	2.6	3.0	3.4	3.8	4.2	4.6	5.0	5.4	5.6	5.8	6.2	6.8
ELA(m^2)						FLOW (L/s)						
0.03	27	27	28	29	29	30	30	31	31	31	32	32
0.04	36	37	38	38	39	40	40	41	41	42	42	43
0.05	45	46	47	48	49	50	50	51	52	52	53	54
0.06	54	55	56	57	59	60	61	62	62	62	63	64
0.07	62	64	66	67	68	70	71	72	72	73	74	75
0.08	71	73	75	77	78	79	81	82	83	83	84	86
0.09	80	82	84	86	88	89	91	92	93	94	95	97
0.10	89	92	94	96	98	99	101	103	103	104	105	107
0.11	98	101	103	105	107	109	111	113	114	114	116	118
0.12	107	110	113	115	117	119	121	123	124	125	126	129
0.13	116	119	122	124	127	129	131	133	134	135	137	140
0.14	25	128	131	134	137	139	141	144	145	146	148	150
0.15	134	137	141	144	146	149	151	154	155	156	158	161
0.16	143	147	150	153	156	159	162	164	165	166	169	172
0.17	152	156	159	163	166	169	172	174	176	177	179	183
0.18	161	165	169	172	176	179	182	185	186	187	190	193
0.19	170	174	178	182	185	189	192	195	196	198	200	204
0.20	179	183	188	192	195	199	202	205	207	208	211	215
0.21	187	192	197	201	205	209	212	215	217	218	221	226
0.22	196	202	206	211	215	219	222	226	227	229	232	236
0.23	205	211	216	220	225	228	232	236	238	239	242	247
0.24	214	220	225	230	234	238	242	246	248	250	253	258
0.25	223	229	234	239	244	248	252	256	258	260	264	269
0.26	232	238	244	249	254	258	263	267	269	270	274	279
0.27	241	247	253	259	264	268	273	277	279	281	285	290

(1a, Atlantic Coast ELA/Air Flow continued)

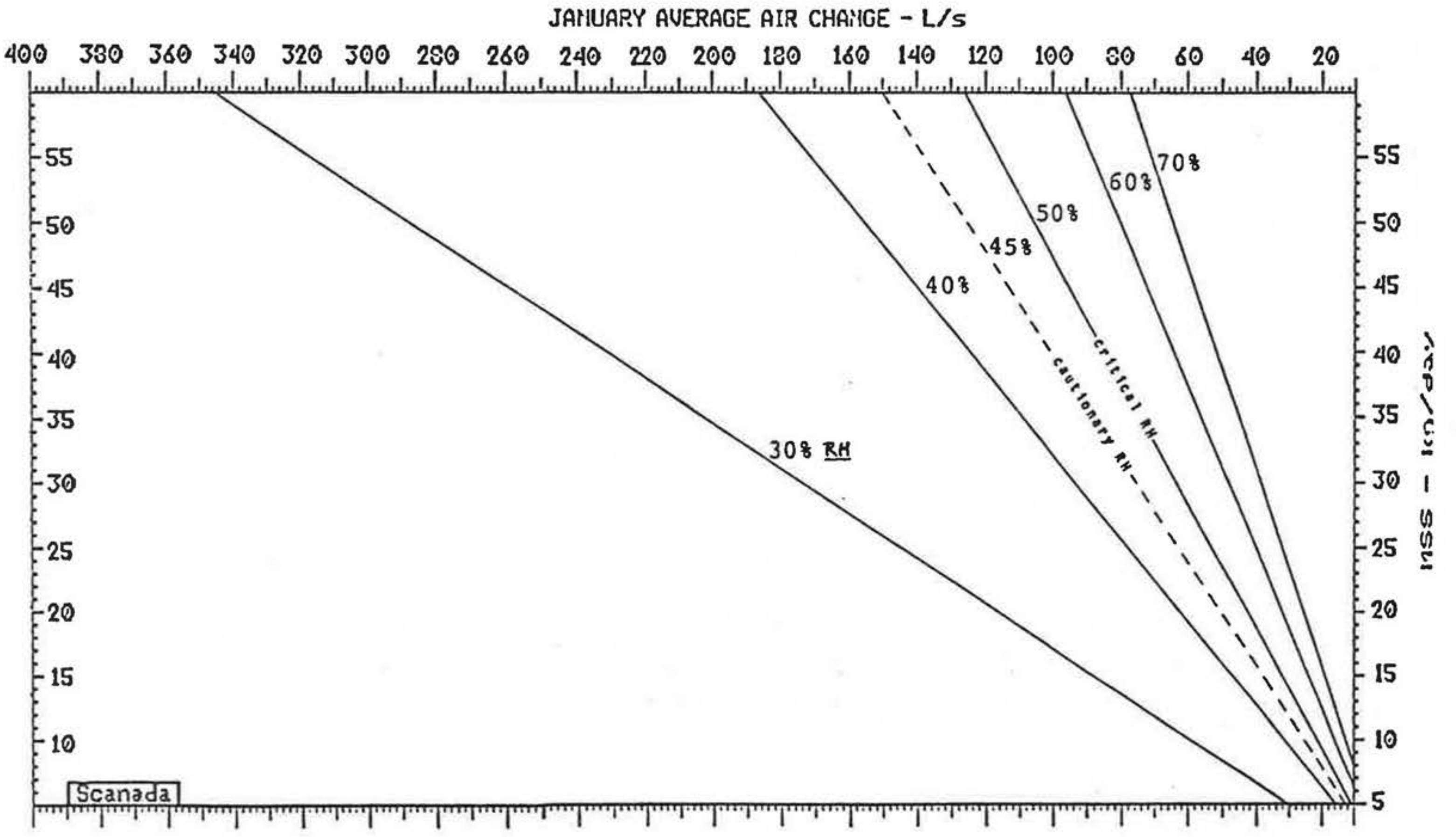
HEIGHT ABOVE GRADE(m)	2.6	BUNGALOW 3.0	3.4	RAISED BUNGALOW 3.8	4.2	4.6	5.0	5.4	2 STOREY 5.6	5.8	6.2	2-1/2 STOREY 6.8
ELA(m^2)						FLOW (L/s)						
0.03	19	20	20	21	21	22	22	23	23	23	24	24
0.04	25	26	27	28	29	29	30	31	31	31	32	33
0.05	31	33	34	35	36	37	37	38	39	39	40	41
0.06	38	39	40	42	43	44	45	46	46	47	48	49
0.07	44	46	47	49	50	51	52	53	54	54	56	57
0.08	50	52	54	56	57	58	60	61	62	62	63	65
0.09	57	59	61	62	64	66	67	69	69	70	71	73
0.10	63	65	67	69	71	73	75	76	77	78	79	81
0.11	69	72	74	76	78	80	82	84	85	86	87	90
0.12	76	78	81	83	86	88	90	92	93	93	95	98
0.13	82	85	88	90	93	95	97	99	100	101	103	106
0.14	88	91	94	97	100	102	105	107	108	109	111	114
0.15	94	98	101	104	107	110	112	114	116	117	119	122
0.16	101	104	108	111	114	117	120	122	123	125	127	130
0.17	107	111	115	118	121	124	127	130	131	132	135	138
0.18	113	117	121	125	128	131	135	137	139	140	143	147
0.19	120	124	128	132	135	139	142	145	146	148	151	155
0.20	126	131	135	139	143	146	149	153	154	156	159	163
0.21	132	137	142	146	150	153	157	160	162	163	167	171
0.22	138	144	148	153	157	161	164	168	170	171	174	179
0.23	145	150	155	160	164	168	172	176	177	179	182	187
0.24	151	157	162	167	171	175	179	183	185	187	190	195
0.25	157	163	169	174	178	183	187	191	193	195	198	204
0.26	164	170	175	180	185	190	194	198	200	202	206	212
0.27	170	176	182	187	192	197	202	206	208	210	214	220

EXPOSURE CLASS 3

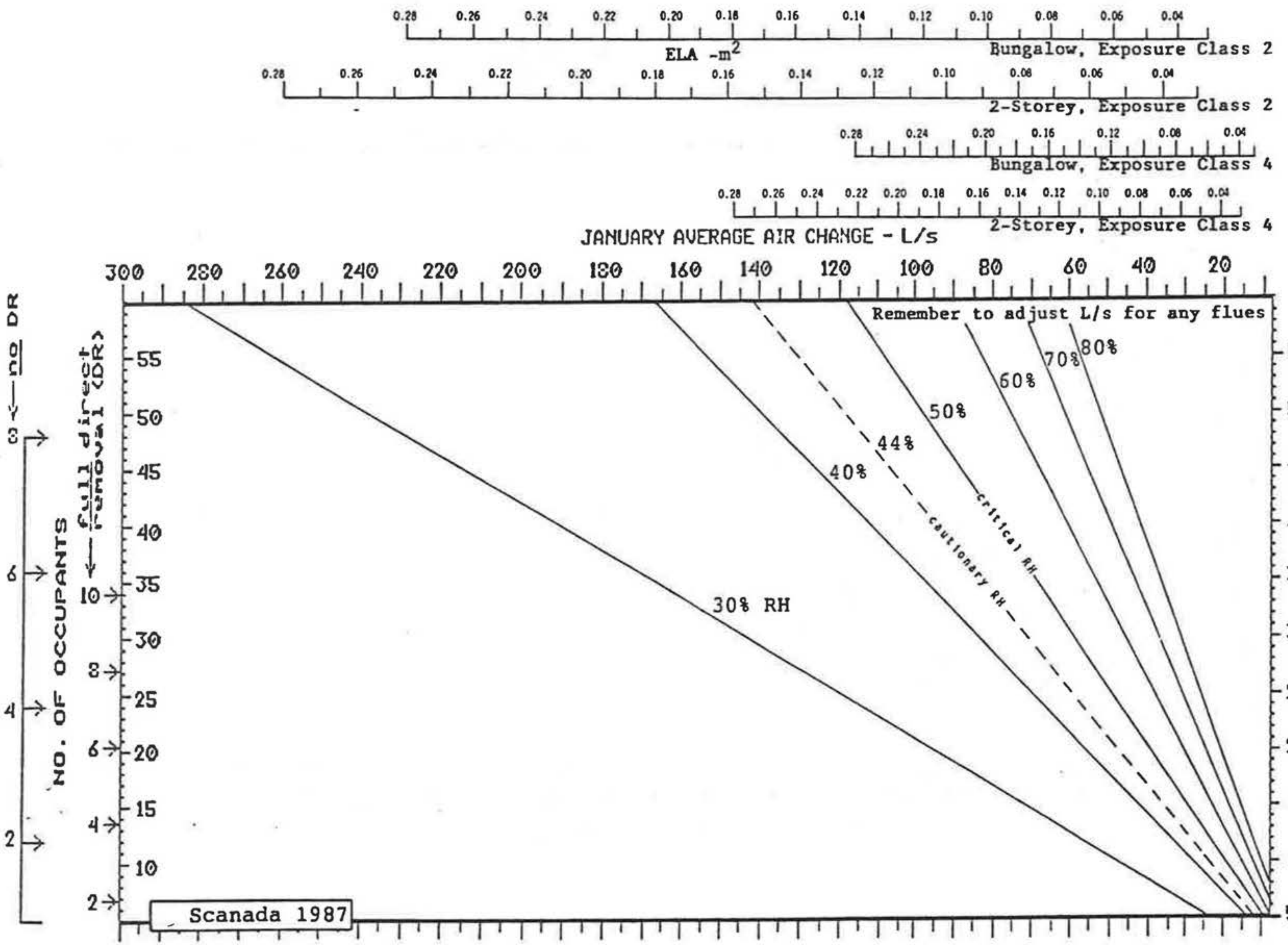
HEIGHT ABOVE GRADE(m)	2.6	3.0	3.4	3.8	4.2	4.6	5.0	5.4	5.6	5.8	6.2	6.8
ELA(m^2)						FLOW (L/s)						
0.03	13	13	14	14	15	15	16	16	17	17	17	18
0.04	17	18	18	19	20	21	21	22	22	22	23	24
0.05	21	22	23	24	25	26	27	27	28	28	29	30
0.06	25	26	28	29	30	31	32	33	33	34	35	36
0.07	29	31	32	34	35	36	37	38	39	39	40	42
0.08	34	35	37	38	40	41	42	44	44	45	46	48
0.09	38	40	41	43	45	46	48	49	50	50	52	54
0.10	42	44	46	48	50	51	53	55	55	56	58	60
0.11	46	48	51	53	55	57	58	60	61	62	63	66
0.12	50	53	55	58	60	62	64	66	66	67	69	71
0.13	54	57	60	62	65	67	69	71	72	73	75	77
0.14	59	62	65	67	70	72	74	76	77	79	81	83
0.15	63	66	69	72	75	77	80	82	83	84	86	89
0.16	67	71	74	77	80	82	85	87	89	90	92	95
0.17	71	75	78	82	85	87	90	93	94	95	98	101
0.18	75	79	83	86	90	93	96	98	100	101	104	107
0.19	80	84	88	91	95	98	101	104	105	107	109	113
0.20	84	88	92	96	100	103	106	109	111	112	115	119
0.21	88	93	97	101	104	108	111	115	116	118	121	125
0.22	92	97	101	106	109	113	117	120	122	123	127	131
0.23	96	101	106	110	114	118	122	126	127	129	132	137
0.24	101	106	111	115	119	123	127	131	133	135	138	143
0.25	105	110	115	120	124	129	133	136	138	140	144	149
0.26	109	115	120	125	129	134	138	142	144	146	150	155
0.27	113	119	124	130	134	139	143	147	149	151	155	161

EXPOSURE CLASS 4

1b) Atlantic Coast: Midwinter Air Flow/MSS/RH
(MSS: moisture source strength; moisture generation rate)



INDOOR RH DETERMINED BY AIR FLOW AND MSS, ST. JOHN'S
(assuming 20°C indoors)



THE ONE-PAGE MAPP, TORONTO, ONT

2a) Inland Mild (Toronto): ELA/Air Flow

EXPOSURE CLASS 1

HEIGHT ABOVE GRADE(m)	2.6	3.0 BUNGALOW	3.4	3.8 RAISED BUNGALOW	4.2	4.6	5.0	5.4	5.6 2 STOREY	5.8	6.2	6.8 2-1/2 STOREY
ELA(m^2)						FLOW (L/s)						
0.03	37	37	38	38	39	39	40	40	40	40	41	41
0.04	49	50	50	51	52	52	53	53	54	54	54	55
0.05	61	62	63	64	65	65	66	67	67	67	68	69
0.06	73	74	76	77	78	78	79	80	81	81	82	83
0.07	85	87	88	89	90	92	93	93	94	94	95	96
0.08	97	99	101	102	103	105	106	107	107	108	109	110
0.09	110	112	113	115	116	118	119	120	121	121	122	124
0.10	122	124	126	128	129	131	132	134	134	135	136	138
0.11	134	136	138	140	142	144	145	147	148	148	150	152
0.12	146	149	151	153	155	157	159	160	161	162	163	165
0.13	158	161	164	166	168	170	172	174	174	175	177	179
0.14	171	173	176	179	181	183	185	187	188	189	191	193
0.15	183	186	189	191	194	196	198	200	201	202	204	207
0.16	195	198	201	204	207	209	212	214	215	216	218	221
0.17	207	211	214	217	220	222	225	227	228	229	231	234
0.18	219	223	227	230	233	235	238	240	242	243	245	248
0.19	231	235	239	242	246	248	251	254	255	256	259	262
0.20	244	248	252	255	258	262	264	267	268	270	272	276
0.21	256	260	264	268	271	275	278	280	282	283	286	289
0.22	268	273	277	281	284	288	291	294	295	297	299	303
0.23	280	285	289	294	297	301	304	307	309	310	313	317
0.24	292	297	302	306	310	314	317	321	322	324	327	331
0.25	304	310	315	319	323	327	331	334	336	337	340	345
0.26	317	322	327	332	336	340	344	347	349	351	354	358
0.27	329	335	340	345	349	353	357	361	362	364	367	372

EXPOSURE CLASS 2

HEIGHT ABOVE GRADE(m)	2.6	3.0	3.4	3.8	4.2	4.6	5.0	5.4	5.6	5.8	6.2	6.8
ELA(m^2)						FLOW (L/s)						
0.03	24	25	25	26	26	27	27	28	28	28	29	29
0.04	32	33	34	34	35	36	36	37	37	38	38	39
0.05	40	41	42	43	44	45	45	46	47	47	48	49
0.06	48	49	50	52	53	54	55	55	56	56	57	58
0.07	56	57	59	60	61	63	64	65	65	66	67	68
0.08	64	66	67	69	70	72	73	74	75	75	76	78
0.09	72	74	76	77	79	80	82	83	84	84	86	87
0.10	80	82	84	86	88	89	91	92	93	94	95	97
0.11	88	90	93	95	97	98	100	102	102	103	105	107
0.12	96	98	101	103	105	107	109	111	112	113	114	117
0.13	104	107	109	112	114	116	118	120	121	122	124	126
0.14	112	115	118	120	123	125	127	129	130	131	133	136
0.15	120	123	126	129	132	134	136	139	140	141	143	146
0.16	128	131	135	138	140	143	146	148	149	150	152	155
0.17	136	140	143	146	149	152	155	157	158	160	162	165
0.18	144	148	151	155	158	161	164	166	168	169	171	175
0.19	152	156	160	163	167	170	173	176	177	178	181	185
0.20	160	164	168	172	175	179	182	185	186	188	190	194
0.21	168	172	177	181	184	188	191	194	196	197	200	204
0.22	176	181	185	189	193	197	200	203	205	206	209	214
0.23	184	189	193	198	202	206	209	213	214	216	219	223
0.24	192	197	202	206	211	215	218	222	224	225	229	233
0.25	200	205	210	215	219	223	227	231	233	235	238	243
0.26	208	213	219	224	228	232	236	240	242	244	248	253
0.27	216	222	227	232	237	241	246	250	252	253	257	262

(2a, Inland Mild ELA/Air Flow continued)

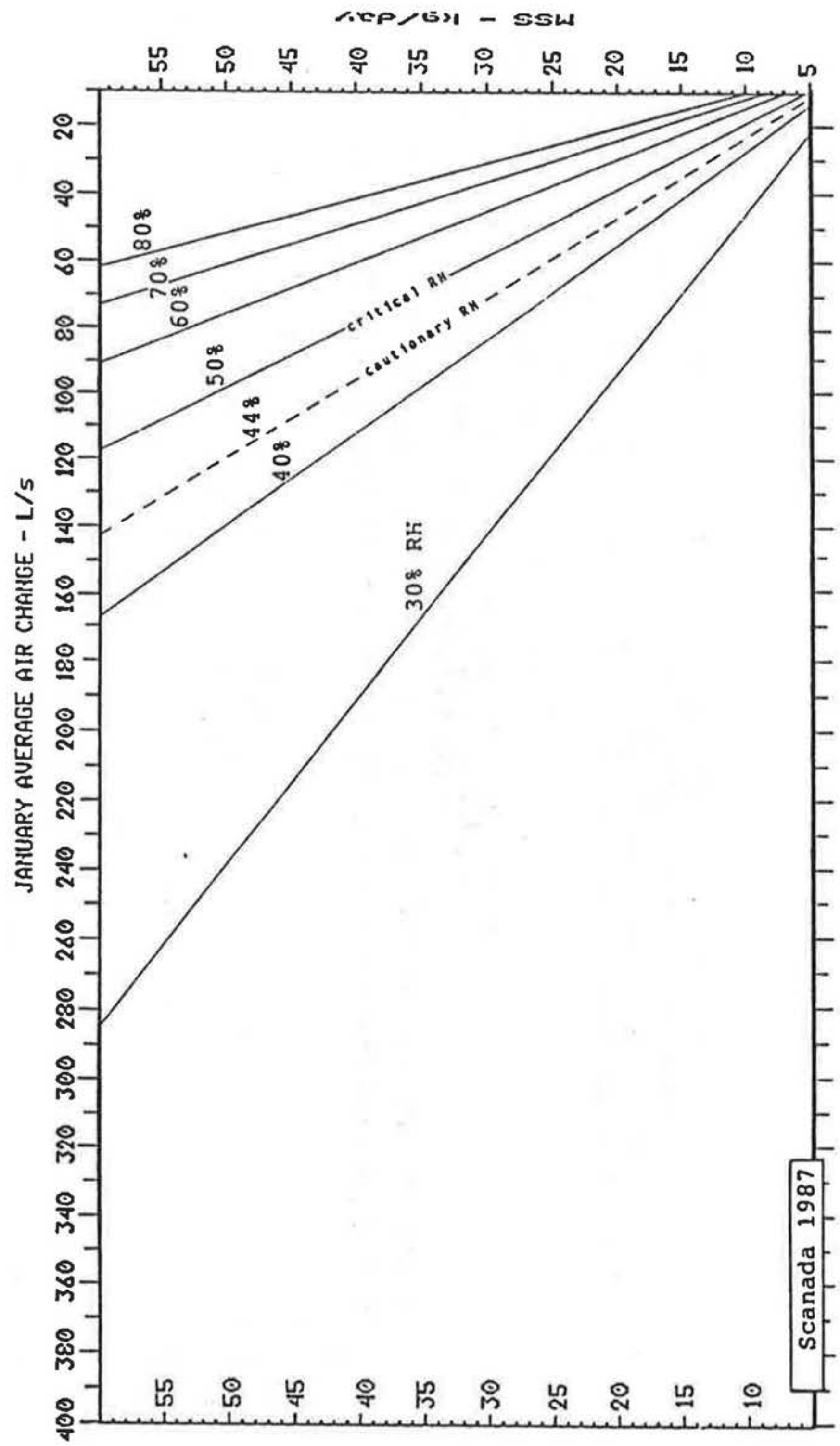
EXPOSURE CLASS 3

HEIGHT ABOVE GRADE(m)	2.6	3.0 BUNGALOW	3.4	3.8 RAISED BUNGALOW	4.2	4.6	5.0	5.4	5.6 2 STOREY	5.8	6.2	6.8 2-1/2 STOREY
ELA(m^2)						FLOW (L/s)						
0.03	17	18	18	19	20	20	21	21	21	21	22	22
0.04	23	24	25	25	26	27	27	28	28	29	29	30
0.05	29	30	31	32	33	33	34	35	35	36	36	37
0.06	34	36	37	38	39	40	41	42	42	43	44	45
0.07	40	42	43	44	46	47	48	49	50	50	51	52
0.08	46	47	49	51	52	53	55	56	57	57	58	60
0.09	51	53	55	57	59	60	62	63	64	64	66	67
0.10	57	59	61	63	65	67	68	70	71	71	73	75
0.11	63	65	68	70	72	74	75	77	78	79	80	82
0.12	68	71	74	76	78	80	82	84	85	86	88	90
0.13	74	77	80	82	85	87	89	91	92	93	95	97
0.14	80	83	86	89	91	94	96	98	99	100	102	105
0.15	86	89	92	95	98	100	103	105	106	107	109	112
0.16	91	95	98	101	104	107	110	112	113	114	117	120
0.17	97	101	104	108	111	114	116	119	120	122	124	127
0.18	103	107	110	114	117	120	123	126	127	129	131	135
0.19	108	113	117	120	124	127	130	133	134	136	139	142
0.20	114	119	123	127	130	134	137	140	142	143	146	150
0.21	120	125	129	133	137	140	144	147	149	150	153	157
0.22	126	130	135	139	143	147	151	154	156	157	160	165
0.23	131	136	141	146	150	154	157	161	163	164	168	172
0.24	137	142	147	152	156	160	164	168	170	172	175	180
0.25	143	148	153	158	163	167	171	175	177	179	182	187
0.26	148	154	160	165	169	174	178	182	184	186	190	195
0.27	154	160	166	171	176	180	185	189	191	193	197	202

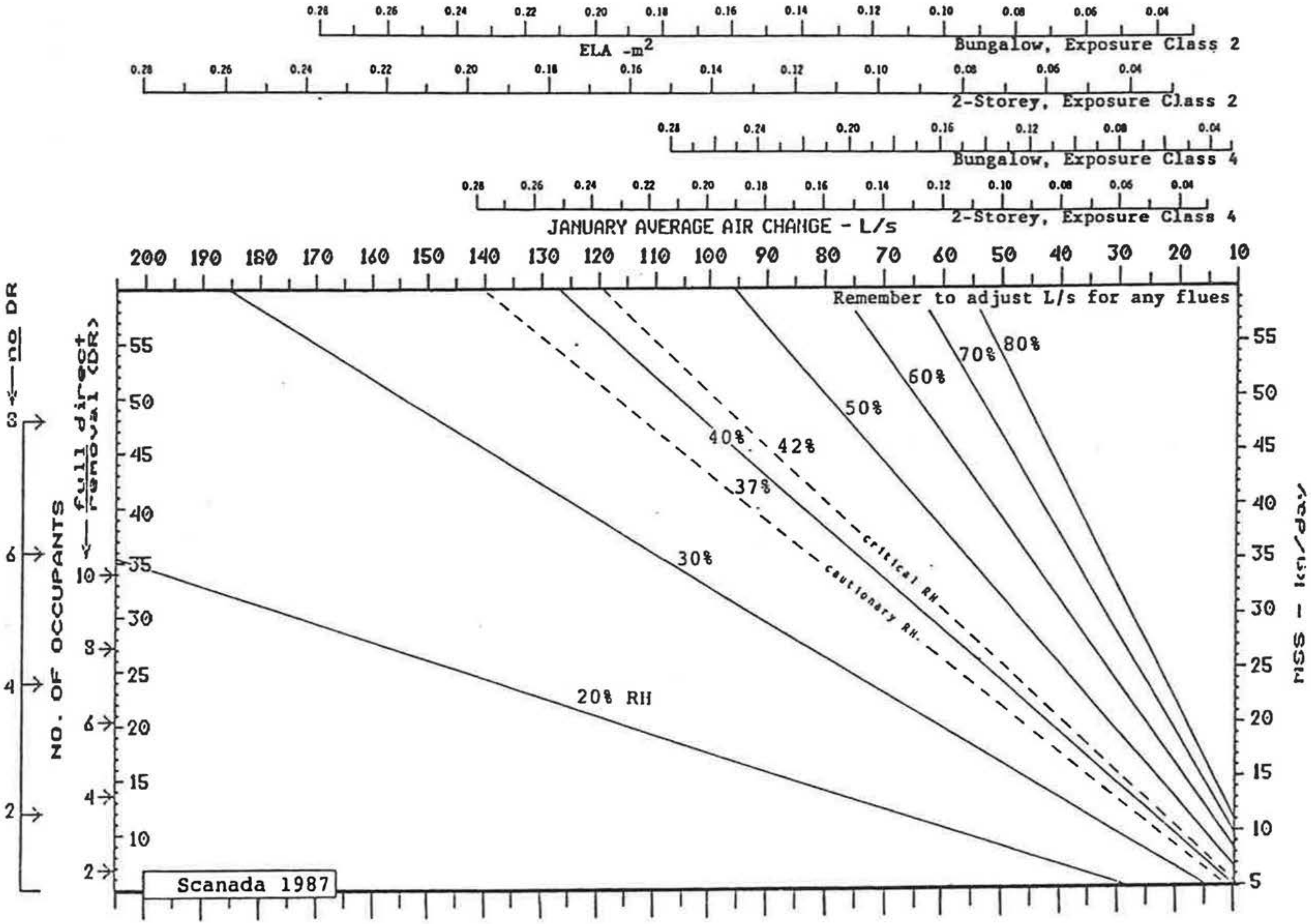
EXPOSURE CLASS 4

HEIGHT ABOVE GRADE(m)	2.6	3.0	3.4	3.8	4.2	4.6	5.0	5.4	5.6	5.8	6.2	6.8
ELA(m^2)						FLOW (L/s)						
0.03	12	12	13	14	14	15	15	16	16	16	16	17
0.04	16	17	17	18	19	19	20	21	21	21	22	23
0.05	20	21	22	23	24	24	25	26	26	27	27	28
0.06	24	25	26	27	28	29	30	31	32	32	33	34
0.07	28	29	30	32	33	34	35	36	37	37	38	40
0.08	31	33	35	36	38	39	40	41	42	43	44	45
0.09	35	37	39	41	42	44	45	47	47	48	49	51
0.10	39	41	43	45	47	49	50	52	53	53	55	57
0.11	43	46	48	50	52	54	55	57	58	59	60	62
0.12	47	50	52	54	56	58	60	62	63	64	66	68
0.13	51	54	56	59	61	63	65	67	68	69	71	74
0.14	55	58	61	63	66	68	70	73	74	75	77	80
0.15	59	62	65	68	71	73	76	78	79	80	82	85
0.16	63	66	69	72	75	78	81	83	84	85	88	91
0.17	67	70	74	77	80	83	86	88	89	91	93	97
0.18	71	75	78	82	85	88	91	93	95	96	99	102
0.19	75	79	83	86	89	93	96	99	100	101	104	108
0.20	79	83	87	91	94	97	101	104	105	107	110	114
0.21	83	87	91	95	99	102	106	109	110	112	115	119
0.22	86	91	96	100	104	107	111	114	116	117	120	125
0.23	90	95	100	104	108	112	116	119	121	123	126	131
0.24	94	99	104	109	113	117	121	124	126	128	131	136
0.25	98	104	109	113	118	122	126	130	132	133	137	142
0.26	102	108	113	118	122	127	131	135	137	139	142	148
0.27	106	112	117	122	127	132	136	140	142	144	148	153

2b) Inland Mild: Midwinter Air Flow/MSS/RH



3. Inland Medium: One-Page MAPP



THE ONE-PAGE MAPP, OTTAWA, ONT

3a) Inland Medium (Ottawa): ELA/Air Flow

EXPOSURE CLASS 1

HEIGHT ABOVE GRADE(m)	2.6	3.0 BUNGALOW	3.4	3.8 RAISED BUNGALOW	4.2	4.6	5.0	5.4	5.6 2 STOREY	5.8	6.2	6.8 2-1/2 STOREY
ELA(m^2)	FLOW (L/s)											
0.03	25	26	26	27	27	28	28	28	29	29	29	30
0.04	34	34	35	36	36	37	37	38	38	38	39	40
0.05	42	43	44	45	45	46	47	47	48	48	49	50
0.06	50	51	52	53	54	55	56	57	57	58	58	59
0.07	59	60	61	62	63	64	65	66	67	67	68	69
0.08	67	69	70	71	72	74	75	76	76	77	78	79
0.09	75	77	79	80	82	83	84	85	86	86	88	89
0.10	84	86	87	89	91	92	93	95	95	96	97	99
0.11	92	94	96	98	100	101	103	104	105	106	107	109
0.12	101	103	105	107	109	110	112	114	115	115	117	119
0.13	109	111	114	116	118	120	121	123	124	125	127	129
0.14	117	120	122	125	127	129	131	133	134	135	136	139
0.15	126	129	131	134	136	138	140	142	143	144	146	149
0.16	134	137	140	142	145	147	150	152	153	154	156	159
0.17	142	146	149	151	154	157	159	161	162	163	165	168
0.18	151	154	157	160	163	166	168	171	172	173	175	178
0.19	159	163	166	169	172	175	178	180	181	183	185	188
0.20	168	171	175	178	181	184	187	190	191	192	195	198
0.21	176	180	184	187	190	193	196	199	200	202	204	208
0.22	184	188	192	196	199	203	206	209	210	211	214	218
0.23	193	197	201	205	208	212	215	218	220	221	224	228
0.24	201	206	210	214	217	221	224	228	229	231	234	238
0.25	209	214	219	223	226	230	234	237	239	240	243	248
0.26	218	223	227	232	236	239	243	246	248	250	253	258
0.27	226	231	236	240	245	249	252	256	258	259	263	268

EXPOSURE CLASS 2

HEIGHT ABOVE GRADE(m)	2.6	3.0	3.4	3.8	4.2	4.6	5.0	5.4	5.6	5.8	6.2	6.8
ELA(m^2)	FLOW (L/s)											
0.03	17	18	19	19	20	20	21	21	21	22	22	23
0.04	23	24	25	26	26	27	28	28	29	29	29	30
0.05	29	30	31	32	33	34	35	35	36	36	37	38
0.06	35	36	37	38	39	40	41	42	43	43	44	45
0.07	41	42	44	45	46	47	48	49	50	50	51	53
0.08	46	48	50	51	53	54	55	56	57	58	59	60
0.09	52	54	56	58	59	61	62	63	64	65	66	68
0.10	58	60	62	64	66	67	69	71	71	72	73	75
0.11	64	66	68	70	72	74	76	78	78	79	81	83
0.12	70	72	75	77	79	81	83	85	86	86	88	91
0.13	75	78	81	83	85	88	90	92	93	94	95	98
0.14	81	84	87	90	92	94	97	99	100	101	103	106
0.15	87	90	93	96	99	101	104	106	107	108	110	113
0.16	93	98	99	102	105	108	110	113	114	115	117	121
0.17	99	102	106	109	112	115	117	120	121	122	125	128
0.18	105	108	112	115	118	121	124	127	128	130	132	136
0.19	110	114	118	122	125	128	131	134	135	137	140	143
0.20	116	120	124	128	132	135	138	141	143	144	147	151
0.21	122	126	131	134	138	142	145	148	150	151	154	159
0.22	128	132	137	141	145	148	152	155	157	158	162	166
0.23	134	138	143	147	151	155	159	162	164	166	169	174
0.24	139	144	149	154	158	162	166	169	171	173	176	181
0.25	145	150	155	160	164	169	173	176	178	180	184	189
0.26	151	156	162	166	171	175	179	183	185	187	191	196
0.27	157	162	168	173	178	182	186	190	192	194	198	204

(<u>3a, Inland Medium ELA/Air Flow continued</u>)

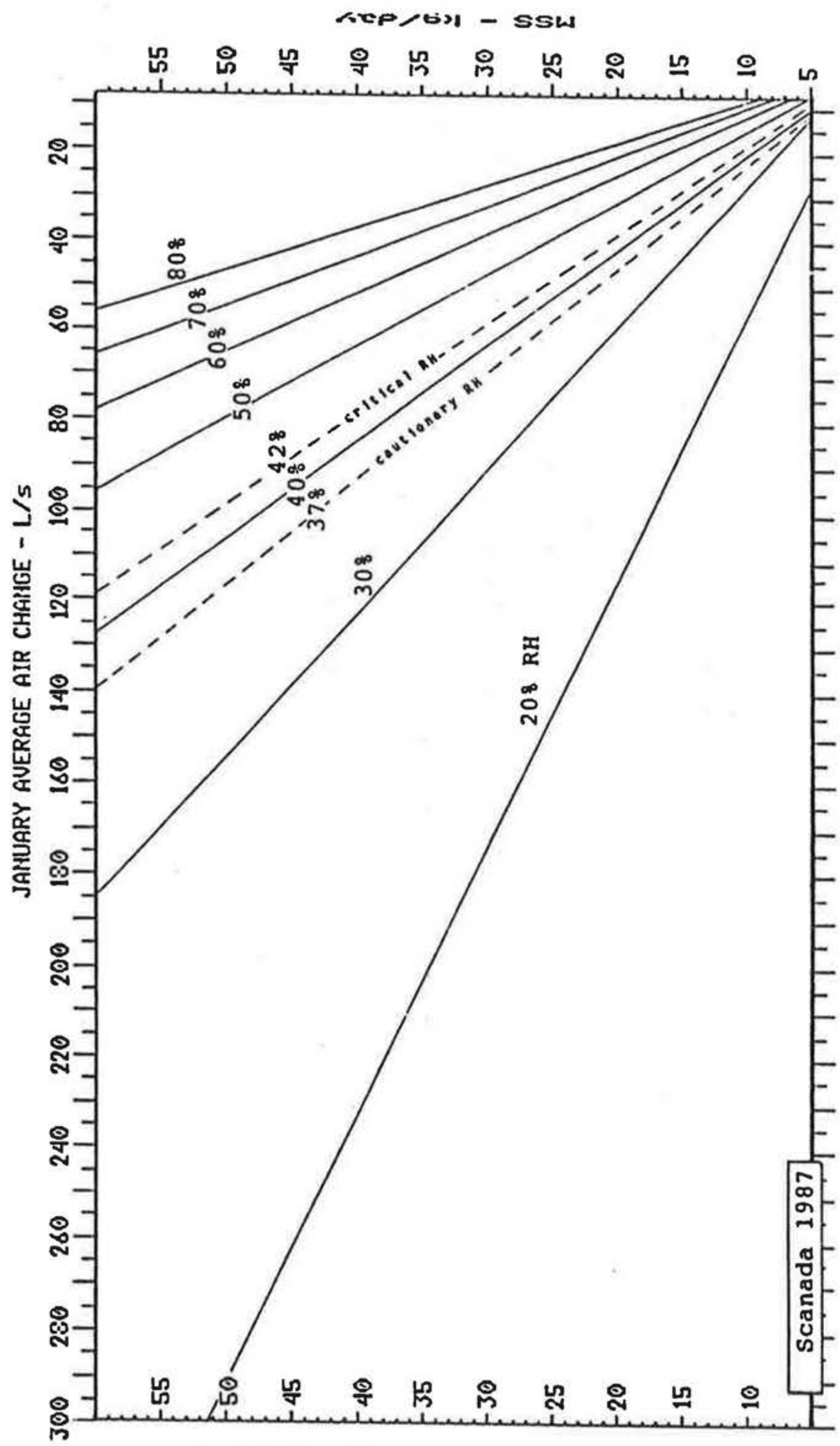
HEIGHT ABOVE GRADE(m)	2.6	3.0 BUNGALOW	3.4	3.8 RAISED BUNGALOW	4.2	4.6	5.0	5.4	5.6 2 STOREY	5.8	6.2	6.8 2-1/2 STOREY
ELA(m^2)						FLOW (L/s)						
0.03	14	14	15	15	16	17	17	18	18	18	18	19
0.04	18	19	20	21	21	22	23	23	24	24	25	25
0.05	23	24	25	26	27	28	28	29	30	30	31	32
0.06	27	28	30	31	32	33	34	35	35	36	37	38
0.07	32	33	35	36	37	39	40	41	41	42	43	45
0.08	36	38	40	41	43	44	45	47	47	48	49	51
0.09	41	43	44	46	48	50	51	53	53	54	55	57
0.10	45	47	49	51	53	55	57	58	59	60	61	64
0.11	50	52	54	56	59	61	62	64	65	66	68	70
0.12	54	57	59	62	64	66	68	70	71	72	74	76
0.13	59	61	64	67	69	72	74	76	77	78	80	83
0.14	63	66	69	72	75	77	79	82	83	84	86	89
0.15	68	71	74	77	80	83	85	88	89	90	92	95
0.16	72	76	79	82	85	88	91	93	95	96	98	102
0.17	77	80	84	87	90	94	96	99	101	102	104	108
0.18	81	85	89	92	96	99	102	105	106	108	111	115
0.19	86	90	94	98	101	105	108	111	112	114	117	121
0.20	90	95	99	103	106	110	113	117	118	120	123	127
0.21	95	99	104	108	112	116	119	123	124	126	129	134
0.22	99	104	109	113	117	121	125	128	130	132	135	140
0.23	104	109	114	118	122	127	130	134	136	138	141	146
0.24	108	113	119	123	128	132	136	140	142	144	147	153
0.25	113	118	123	128	133	138	142	146	148	150	154	159
0.26	117	123	128	134	138	143	147	152	154	156	160	165
0.27	122	128	133	139	144	149	153	158	160	162	166	172

EXPOSURE CLASS 3

HEIGHT ABOVE GRADE(m)	2.6	3.0	3.4	3.8	4.2	4.6	5.0	5.4	5.6	5.8	6.2	6.8
ELA(m^2)						FLOW (L/s)						
0.03	11	11	12	13	13	14	14	15	15	15	16	16
0.04	14	15	16	17	18	18	19	20	20	20	21	22
0.05	18	19	20	21	22	23	24	25	25	26	26	27
0.06	22	23	24	25	27	28	29	30	30	31	32	33
0.07	25	27	28	30	31	32	33	35	35	36	37	38
0.08	29	31	32	34	35	37	38	40	40	41	42	44
0.09	32	34	36	38	40	41	43	45	45	46	47	49
0.10	36	38	40	42	44	46	48	50	50	51	53	55
0.11	39	42	44	47	49	51	53	54	55	56	58	60
0.12	43	46	48	51	53	55	57	59	60	61	63	66
0.13	47	50	52	55	58	60	62	64	65	66	68	71
0.14	50	53	56	59	62	65	67	69	70	72	74	77
0.15	54	57	60	64	66	69	72	74	75	77	79	82
0.16	57	61	65	68	71	74	77	79	81	82	84	88
0.17	61	65	69	72	75	78	81	84	86	87	90	93
0.18	65	69	73	76	80	83	86	89	91	92	95	99
0.19	68	73	77	80	84	88	91	94	96	97	100	104
0.20	72	76	81	85	89	92	96	99	101	102	105	110
0.21	75	80	85	89	93	97	100	104	106	107	111	115
0.22	79	84	89	93	97	101	105	109	111	112	116	121
0.23	83	88	93	97	102	106	110	114	116	118	121	126
0.24	86	92	97	102	106	111	115	119	121	123	126	132
0.25	90	95	101	106	111	115	120	124	126	128	132	137
0.26	93	99	105	110	115	120	124	129	131	133	137	143
0.27	97	103	109	114	120	124	129	134	136	138	142	148

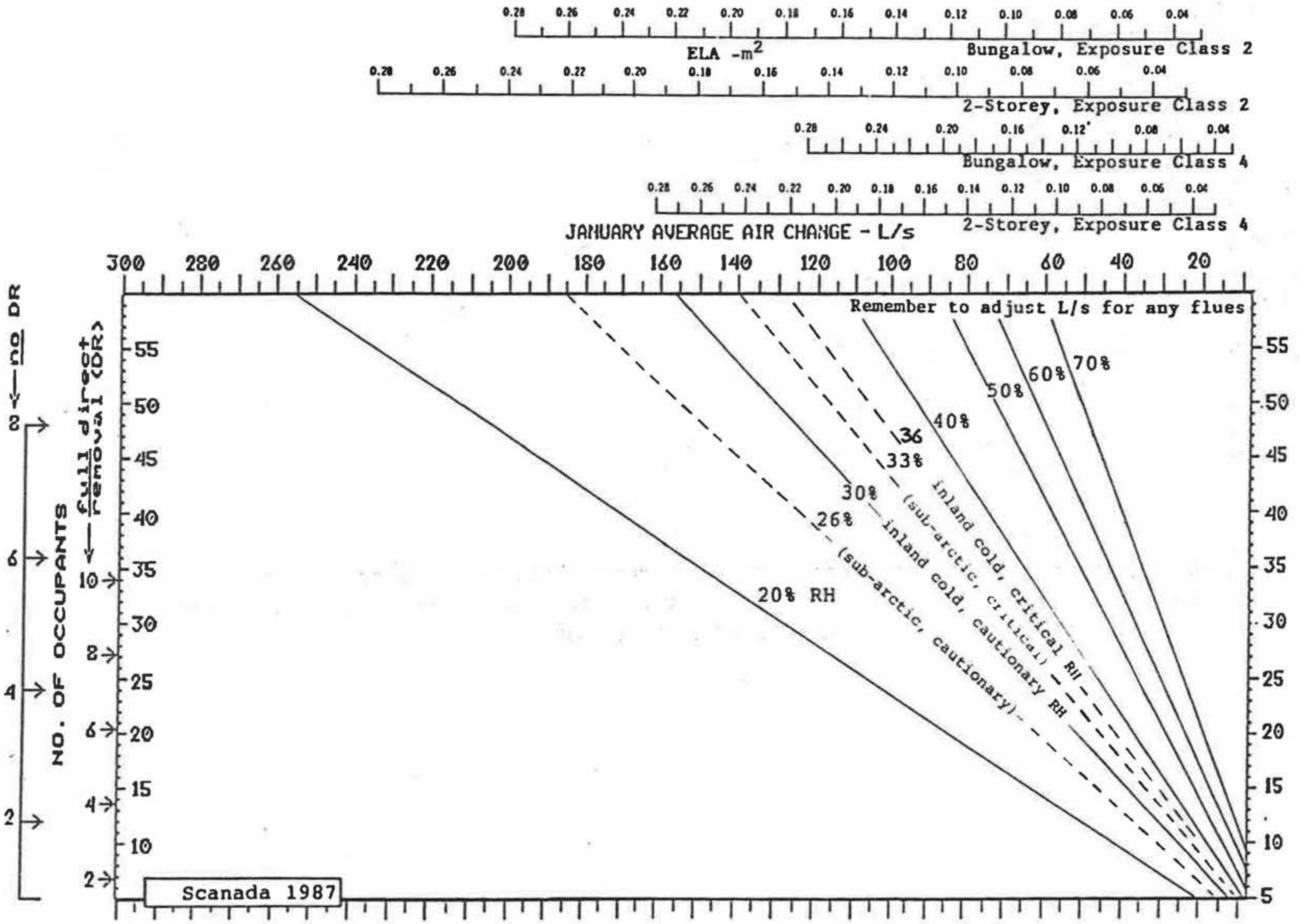
EXPOSURE CLASS 4

3b) <u>Inland Medium: Midwinter Air Flow/MSS/RH</u>



4. Inland Cold: One-Page MAPP

(with suggested sub-arctic limits added)



THE ONE-PAGE MAPP, WINNIPEG, MAN.

4a) Inland Cold (Winnipeg): ELA/Air Flow

HEIGHT ABOVE GRADE(m)	2.6	BUNGALOW 3.0	3.4	RAISED BUNGALOW 3.8	4.2	4.6	5.0	5.4	2 STOREY 5.6	5.8	6.2	2-1/2 STOREY 6.8
ELA(m²)						FLOW (L/s)						
0.03	30	31	31	32	32	33	33	34	34	34	35	36
0.04	40	41	42	42	43	44	44	45	45	46	46	47
0.05	50	51	52	53	54	55	56	56	57	57	58	59
0.06	60	61	63	64	65	66	67	68	68	69	69	71
0.07	70	72	73	74	76	77	78	79	79	80	81	82
0.08	80	82	83	85	86	88	89	90	91	91	93	94
0.09	90	92	94	96	97	99	100	101	102	103	104	106
0.10	100	102	104	106	108	110	111	113	114	114	116	118
0.11	110	113	115	117	119	121	122	124	125	126	127	129
0.12	120	123	125	127	130	132	133	135	136	137	139	141
0.13	130	133	136	138	140	143	145	147	148	149	150	153
0.14	140	143	146	149	151	154	156	158	159	160	162	165
0.15	150	154	157	159	162	164	167	169	170	171	173	177
0.16	160	164	167	170	173	175	178	180	182	183	185	188
0.17	170	174	177	181	184	186	189	192	193	194	197	200
0.18	180	184	188	191	194	197	200	203	204	206	208	212
0.19	190	194	198	202	205	208	211	214	216	217	220	224
0.20	200	205	209	212	216	219	222	226	227	228	231	235
0.21	210	215	219	223	227	230	234	237	238	240	243	247
0.22	220	225	230	234	238	241	245	248	250	251	254	259
0.23	230	235	240	244	248	252	256	259	261	263	266	271
0.24	240	246	250	255	259	263	267	271	272	274	278	282
0.25	250	256	261	266	270	274	278	282	284	286	289	294
0.26	260	266	271	276	281	285	289	293	295	297	301	306
0.27	270	276	282	287	292	296	300	304	306	308	312	318

EXPOSURE CLASS 1

HEIGHT ABOVE GRADE(m)	2.6	3.0	3.4	3.8	4.2	4.6	5.0	5.4	5.6	5.8	6.2	6.8
ELA(m²)						FLOW (L/s)						
0.03	21	21	22	23	23	24	24	25	25	25	26	27
0.04	28	28	29	30	31	32	33	33	34	34	35	35
0.05	34	36	37	38	39	40	41	42	42	42	43	44
0.06	41	43	44	45	47	48	49	50	50	51	52	53
0.07	48	50	51	53	54	56	57	58	59	59	60	62
0.08	55	57	59	60	62	64	65	66	67	68	69	71
0.09	62	64	66	68	70	72	73	75	76	76	78	80
0.10	69	71	74	76	78	80	81	83	84	85	86	89
0.11	76	78	81	83	85	87	89	91	92	93	95	98
0.12	83	85	88	91	93	95	98	100	101	102	104	106
0.13	89	93	96	98	101	103	106	108	109	110	112	115
0.14	96	100	103	106	109	111	114	116	117	119	121	124
0.15	103	107	110	113	116	119	122	125	126	127	130	133
0.16	110	114	118	121	124	127	130	133	134	136	138	142
0.17	117	121	125	129	132	135	138	141	143	144	147	151
0.18	124	128	132	136	140	143	146	150	151	153	155	160
0.19	131	135	140	144	147	151	155	158	159	161	164	168
0.20	138	142	147	151	155	159	163	166	168	169	173	177
0.21	145	150	154	159	163	167	171	174	176	178	181	186
0.22	151	157	162	166	171	175	179	183	185	186	190	195
0.23	158	164	169	174	179	183	187	191	193	195	199	204
0.24	165	171	176	181	186	191	195	199	201	203	207	213
0.25	172	178	184	189	194	199	203	208	210	212	216	222
0.26	179	185	191	197	202	207	211	216	218	220	225	231
0.27	186	192	198	204	210	215	220	224	227	229	233	239

EXPOSURE CLASS 2

(4a, Inland Cold ELA/Air Flow continued)

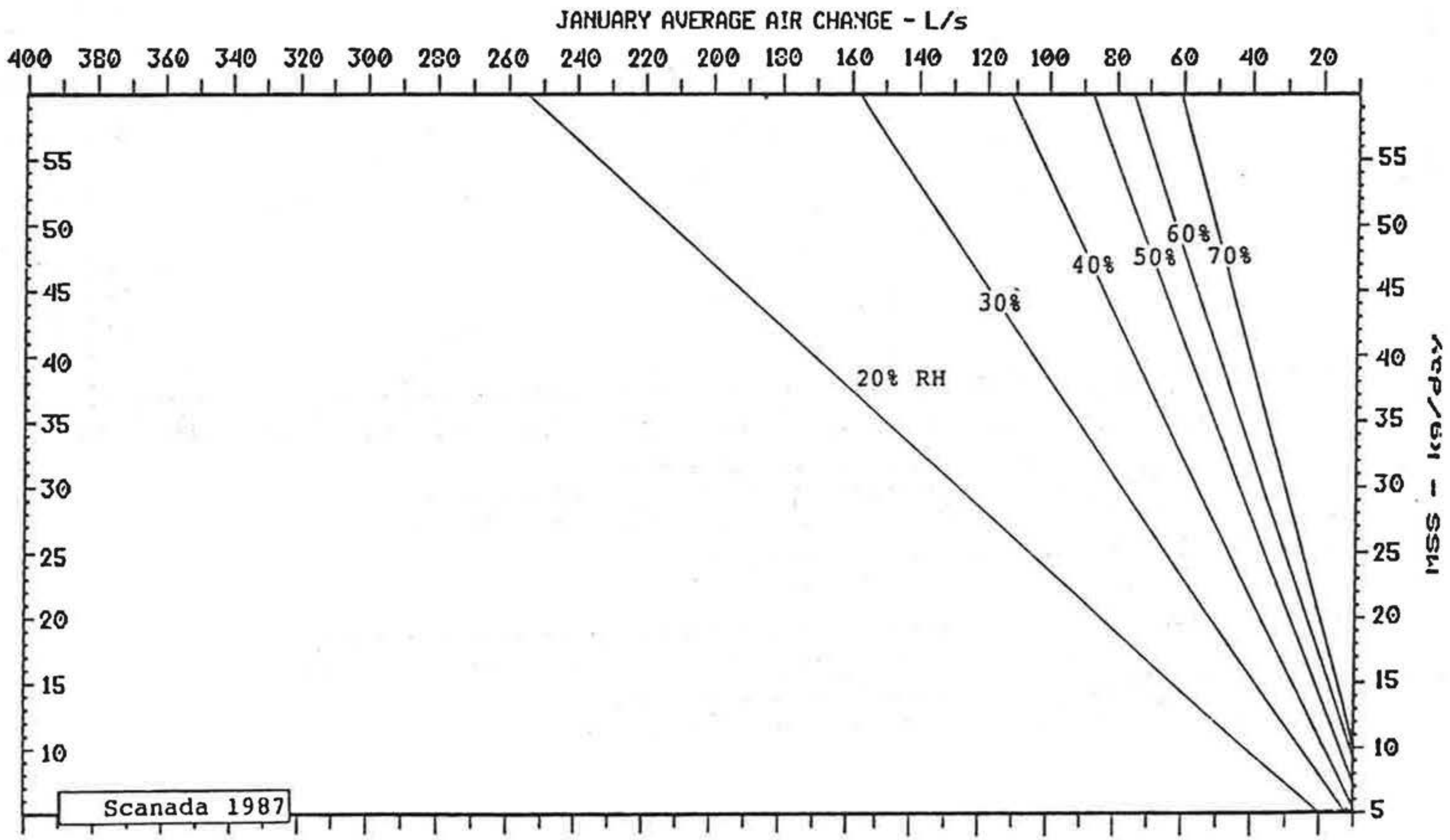
HEIGHT ABOVE GRADE(m)	2.6	BUNGALOW 3.0	3.4	RAISED BUNGALOW 3.8	4.2	4.6	5.0	5.4	2 STOREY 5.6	5.8	6.2	2-1/2 STOREY 6.8
ELA(m^2)						FLOW (L/s)						
0.03	16	17	17	18	19	19	20	20	21	21	21	22
0.04	21	22	23	24	25	26	26	27	28	28	29	30
0.05	26	28	29	30	31	32	33	34	34	35	36	37
0.06	32	33	35	36	37	39	40	41	41	42	43	44
0.07	37	39	40	42	43	45	46	48	48	49	50	52
0.08	42	44	46	48	50	51	53	54	55	56	57	59
0.09	48	50	52	54	56	58	59	61	62	63	64	67
0.10	53	55	58	60	62	64	66	68	69	70	71	74
0.11	58	61	64	66	68	71	73	75	76	77	79	81
0.12	63	66	69	72	75	77	79	82	83	84	86	89
0.13	69	72	75	78	81	83	86	88	90	91	93	96
0.14	74	77	81	84	87	90	93	95	96	98	100	104
0.15	79	83	87	90	93	96	99	102	103	105	107	111
0.16	84	89	92	96	99	103	106	109	110	112	114	118
0.17	90	94	98	102	106	109	112	116	117	119	122	126
0.18	95	100	104	108	112	116	119	122	124	126	129	133
0.19	100	105	110	114	118	122	126	129	131	133	136	141
0.20	106	111	116	120	124	128	132	136	138	140	143	148
0.21	111	116	121	126	130	135	139	143	145	147	150	155
0.22	116	122	127	132	137	141	145	150	152	153	157	163
0.23	121	127	133	138	143	148	152	156	158	160	164	170
0.24	127	133	139	144	149	154	159	163	165	167	172	178
0.25	132	138	144	150	155	160	165	170	172	174	179	185
0.26	137	144	150	156	162	167	172	177	179	181	186	192
0.27	143	149	156	162	168	173	178	184	186	188	193	200

EXPOSURE CLASS 3

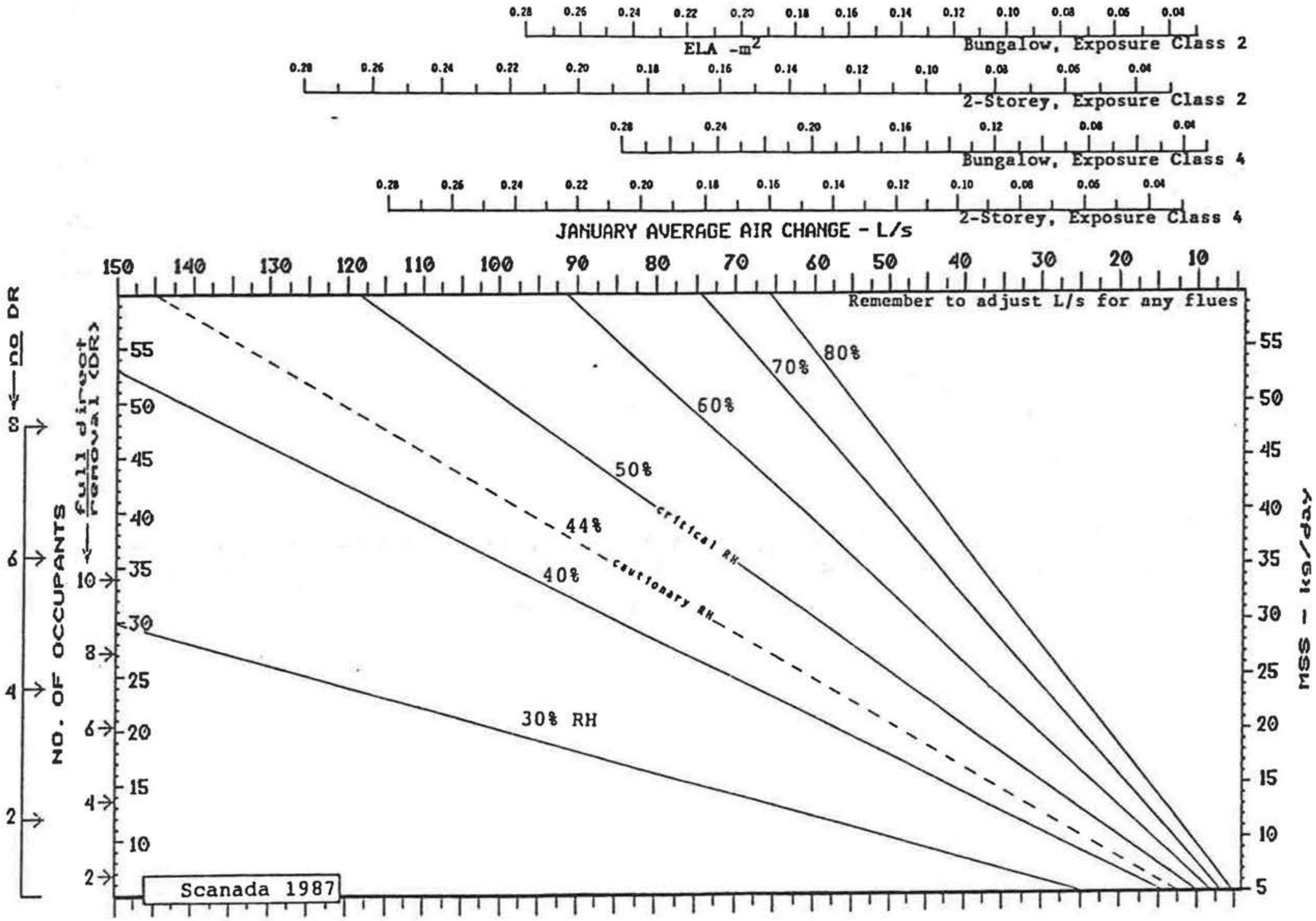
HEIGHT ABOVE GRADE(m)	2.6	3.0	3.4	3.8	4.2	4.6	5.0	5.4	5.6	5.8	6.2	6.8
ELA(m^2)						FLOW (L/s)						
0.03	12	13	14	15	15	16	16	17	17	18	18	19
0.04	17	18	19	20	20	21	22	23	23	23	24	25
0.05	21	22	23	24	25	27	27	28	29	29	30	32
0.06	25	26	28	29	31	32	33	34	35	35	36	38
0.07	29	31	33	34	36	37	38	40	40	41	42	44
0.08	33	35	37	39	41	42	44	46	46	47	48	50
0.09	37	40	42	44	46	48	49	51	52	53	54	57
0.10	41	44	46	49	51	53	55	57	58	59	60	63
0.11	46	48	51	54	56	58	60	63	64	65	67	69
0.12	50	53	56	59	61	64	66	68	69	70	73	76
0.13	54	57	60	63	66	69	71	74	75	76	79	82
0.14	58	62	65	68	71	74	77	80	81	82	85	88
0.15	62	66	70	73	76	80	82	85	87	88	91	95
0.16	66	70	74	78	81	85	88	91	93	94	97	101
0.17	70	75	79	83	87	90	93	97	98	100	103	107
0.18	75	79	84	88	92	95	99	102	104	106	109	113
0.19	79	84	88	93	97	101	104	108	110	112	115	120
0.20	83	88	93	98	102	106	110	114	116	117	121	126
0.21	87	92	98	102	107	111	115	119	121	123	127	132
0.22	91	97	102	107	112	117	121	125	127	129	133	139
0.23	95	101	107	112	117	122	126	131	133	135	139	145
0.24	99	106	112	117	122	127	132	137	139	141	145	151
0.25	104	110	116	122	127	133	137	142	145	147	151	158
0.26	108	114	121	127	132	138	143	148	150	153	157	164
0.27	112	119	125	132	138	143	148	154	156	159	163	170

EXPOSURE CLASS 4

4b) Inland Cold: Midwinter Air Flow/MSS/RH



5. B.C. South Inland/Okanagan: One-Page MAPP



THE ONE-PAGE MAPP, KELOWNA, B.C.

5a) B.C. South Inland and Okanagan (Kelowna): ELA/Air Flow

EXPOSURE CLASS 1

HEIGHT ABOVE GRADE(m)	2.6	3.0 BUNGALOW	3.4	3.8 RAISED BUNGALOW	4.2	4.6	5.0	5.4	5.6 2 STOREY	5.8	6.2	6.8 2-1/2 STOREY
ELA(m^2)						FLOW (L/s)						
0.03	12	12	13	13	14	14	15	15	15	15	16	16
0.04	16	16	17	18	18	19	19	20	20	20	21	22
0.05	20	21	21	22	23	24	24	25	25	26	26	27
0.06	24	25	26	27	27	28	29	30	30	31	31	32
0.07	28	29	30	31	32	33	34	35	35	36	37	38
0.08	31	33	34	35	37	38	39	40	40	41	42	43
0.09	35	37	38	40	41	42	44	45	45	46	47	49
0.10	39	41	43	44	46	47	48	50	50	51	52	54
0.11	43	45	47	49	50	52	53	55	55	56	58	59
0.12	47	49	51	53	55	57	58	60	61	61	63	65
0.13	51	53	56	58	59	61	63	65	66	66	68	70
0.14	55	58	60	62	64	66	68	70	71	72	73	76
0.15	59	62	64	66	69	71	73	75	76	77	78	81
0.16	63	66	68	71	73	75	78	80	81	82	84	87
0.17	67	70	73	75	78	80	82	85	86	87	89	92
0.18	71	74	77	80	82	85	87	90	91	92	94	97
0.19	75	78	81	84	87	90	92	95	96	97	99	103
0.20	79	82	85	88	91	94	97	100	101	102	105	108
0.21	83	86	90	93	96	99	102	105	106	107	110	114
0.22	87	90	94	97	101	104	107	110	111	112	115	119
0.23	91	95	98	102	105	108	112	115	116	117	120	124
0.24	94	99	103	106	110	113	116	120	121	123	126	130
0.25	98	103	107	111	114	118	121	125	126	128	131	135
0.26	102	107	111	115	119	123	126	129	131	133	136	141
0.27	106	111	115	119	123	127	131	134	136	138	141	146

EXPOSURE CLASS 2

HEIGHT ABOVE GRADE(m)	2.6	3.0	3.4	3.8	4.2	4.6	5.0	5.4	5.6	5.8	6.2	6.8
ELA(m^2)						FLOW (L/s)						
0.03	10	10	11	11	12	12	13	13	13	14	14	15
0.04	13	14	15	15	16	17	17	18	18	18	19	20
0.05	16	17	18	19	20	21	21	22	22	23	23	24
0.06	20	21	22	23	24	25	26	26	27	27	28	29
0.07	23	24	25	27	28	29	30	31	31	32	33	34
0.08	26	28	29	30	32	33	34	35	36	36	37	39
0.09	29	31	33	34	36	37	38	40	40	41	42	44
0.10	33	35	36	38	40	41	43	44	45	46	47	49
0.11	36	38	40	42	44	45	47	49	49	50	52	54
0.12	39	42	44	46	48	50	51	53	54	55	56	59
0.13	42	45	47	50	52	54	56	57	58	59	61	63
0.14	46	48	51	53	56	58	60	62	63	64	66	68
0.15	49	52	55	57	60	62	64	66	67	68	70	73
0.16	52	55	58	61	64	66	68	71	72	73	75	78
0.17	56	59	62	65	68	70	73	75	76	77	80	83
0.18	59	62	66	69	71	74	77	79	81	82	84	88
0.19	62	66	69	72	75	78	81	84	85	87	89	93
0.20	65	69	73	76	79	83	85	88	90	91	94	98
0.21	69	73	76	80	83	87	90	93	94	96	98	102
0.22	72	76	80	84	87	91	94	97	99	100	103	107
0.23	75	80	84	88	91	95	98	102	103	105	108	112
0.24	78	83	87	91	95	99	103	106	108	109	112	117
0.25	82	86	91	95	99	103	107	110	112	114	117	122
0.26	85	90	95	99	103	107	111	115	117	118	122	127
0.27	88	93	98	103	107	111	115	119	121	123	127	132

(5a, B.C. South Inland/Okanagan ELA/Air Flow continued)

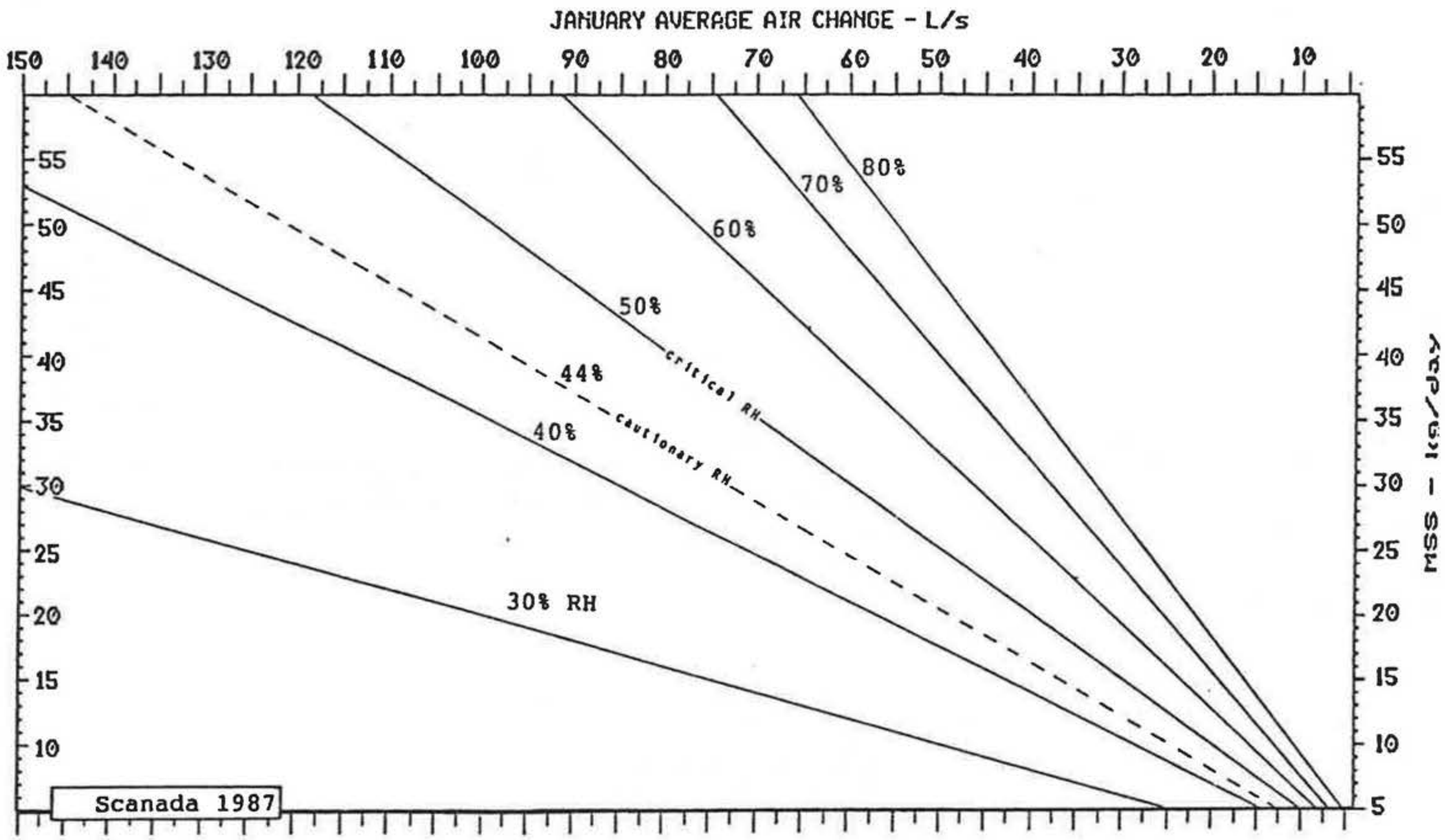
		BUNGALOW		RAISED BUNGALOW					2 STOREY			2-1/2 STOREY
HEIGHT ABOVE GRADE(m)	2.6	3.0	3.4	3.8	4.2	4.6	5.0	5.4	5.6	5.8	6.2	6.8
ELA(m^2)						FLOW (L/s)						
0.03	9	10	10	11	11	12	12	13	13	13	13	14
0.04	12	13	13	14	15	15	16	17	17	17	18	19
0.05	15	16	17	18	19	19	20	21	21	22	22	23
0.06	18	19	20	21	22	23	24	25	25	26	27	28
0.07	21	22	24	25	26	27	28	29	30	30	31	33
0.08	24	25	27	28	30	31	32	33	34	35	36	37
0.09	27	29	30	32	33	35	36	38	38	39	40	42
0.10	30	32	34	35	37	39	40	42	42	43	45	47
0.11	33	35	37	39	41	43	44	46	47	47	49	51
0.12	36	38	40	43	45	46	48	50	51	52	53	56
0.13	39	41	44	46	48	50	52	54	55	56	58	60
0.14	42	45	47	50	52	54	56	58	59	60	62	65
0.15	45	48	51	53	56	58	60	63	64	65	67	70
0.16	48	51	54	57	59	62	64	67	68	69	71	74
0.17	51	54	57	60	63	66	68	71	72	73	76	79
0.18	54	57	61	64	67	70	72	75	76	78	80	84
0.19	57	60	64	67	71	74	77	79	81	82	85	88
0.20	60	64	67	71	74	77	81	83	85	86	89	93
0.21	63	67	71	74	78	81	85	88	89	91	94	98
0.22	66	70	74	78	82	85	89	92	93	95	98	102
0.23	69	73	78	82	85	89	93	96	98	99	102	107
0.24	72	76	81	85	89	93	97	100	102	104	107	112
0.25	75	80	84	89	93	97	101	104	106	108	111	116
0.26	78	83	88	92	97	101	105	109	110	112	116	121
0.27	81	86	91	96	100	105	109	113	115	117	120	126

EXPOSURE CLASS 3

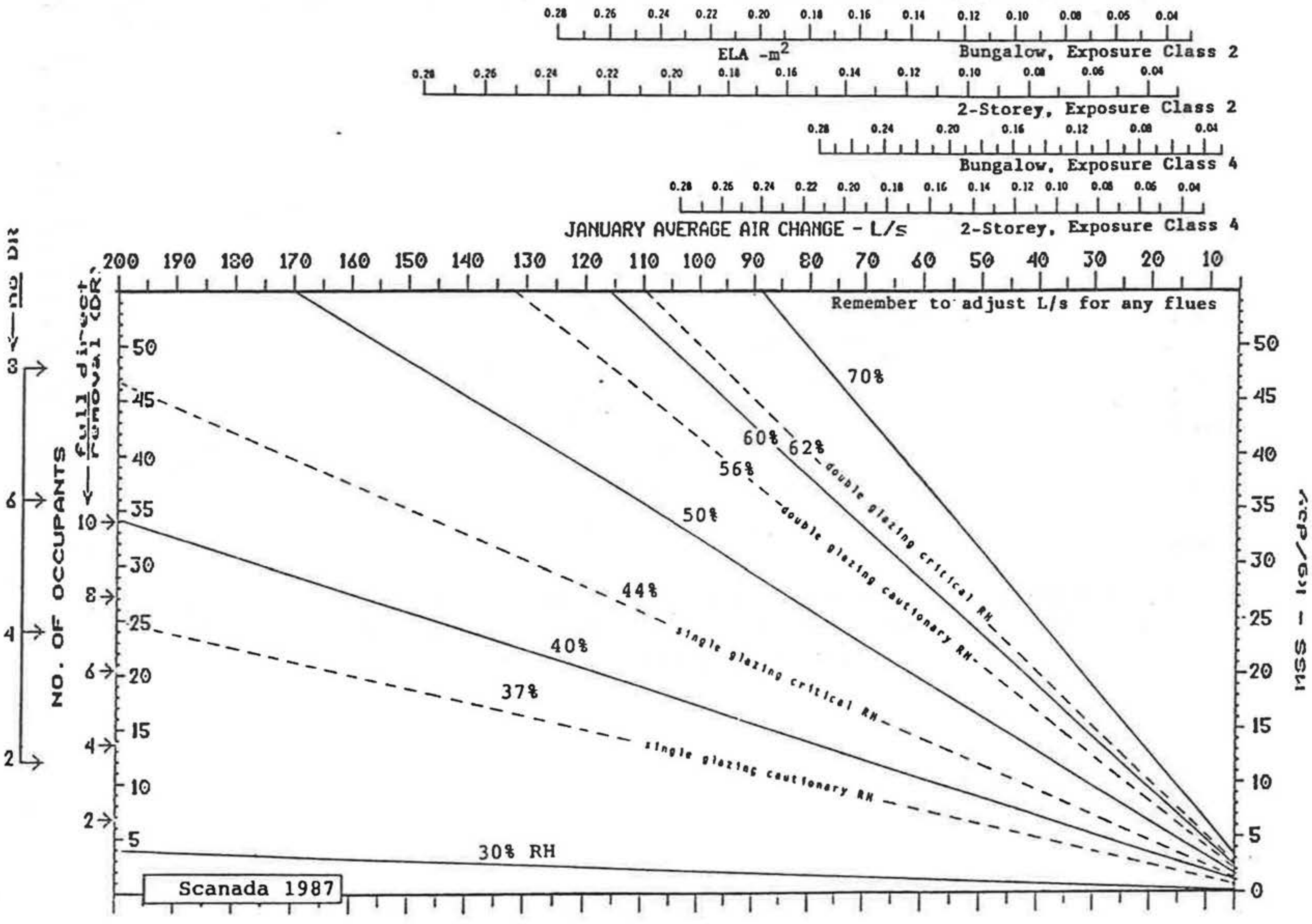
HEIGHT ABOVE GRADE(m)	2.6	3.0	3.4	3.8	4.2	4.6	5.0	5.4	5.6	5.8	6.2	6.8
ELA(m^2)						FLOW (L/s)						
0.03	8	9	10	10	11	11	12	12	12	12	13	14
0.04	11	12	13	14	14	15	15	16	16	17	17	18
0.05	14	15	16	17	18	19	19	20	20	21	22	23
0.06	17	18	19	20	21	22	23	24	25	25	26	27
0.07	20	21	22	24	25	26	27	28	29	29	30	32
0.08	23	24	26	27	28	30	31	32	33	33	34	36
0.09	25	27	29	30	32	33	35	36	37	37	39	41
0.10	28	30	32	34	36	37	39	40	41	42	43	45
0.11	31	33	35	37	39	41	43	44	45	46	47	50
0.12	34	36	38	41	43	45	46	48	49	50	52	54
0.13	37	39	42	44	46	48	50	52	53	54	56	59
0.14	39	42	45	47	50	52	54	56	57	58	60	63
0.15	42	45	48	51	53	56	58	60	61	62	65	68
0.16	45	48	51	54	57	59	62	64	65	67	69	72
0.17	48	51	55	58	60	63	66	68	70	71	73	77
0.18	51	54	58	61	64	67	70	72	74	75	77	81
0.19	53	57	61	64	68	71	74	76	78	79	82	86
0.20	56	60	64	68	71	74	77	80	82	83	86	90
0.21	59	63	67	71	75	78	81	84	86	87	90	95
0.22	62	66	71	74	78	82	85	88	90	92	95	99
0.23	65	69	74	78	82	85	89	92	94	96	99	104
0.24	68	72	77	81	85	89	93	96	98	100	103	108
0.25	70	75	80	85	89	93	97	101	102	104	108	113
0.26	73	78	83	88	92	97	101	105	106	108	112	117
0.27	76	81	87	91	96	100	105	109	110	112	116	122

EXPOSURE CLASS 4

5b) B.C. South Inland/Okanagan: Midwinter Air Flow/MSS/RH



6. B.C. S. Coast/S. Vanc. Isl.: One-Page MAPP



THE ONE-PAGE MAPP, VANCOUVER, B.C.

6a) B.C. South Coast/South Vancouver Island (Vancouver): ELA/Air Flow

EXPOSURE CLASS 1

HEIGHT ABOVE GRADE(m)	2.6	3.0 BUNGALOW	3.4	3.8 RAISED BUNGALOW	4.2	4.6	5.0	5.4	5.6 2 STOREY	5.8	6.2	6.8 2-1/2 STOREY
ELA(m²)						FLOW (L/s)						
0.03	19	19	20	20	20	21	21	21	21	21	22	22
0.04	25	26	26	27	27	27	28	28	28	29	29	30
0.05	31	32	33	33	34	34	35	35	36	36	36	37
0.06	38	38	39	40	41	41	42	42	43	43	44	44
0.07	44	45	46	47	47	48	49	49	50	50	51	52
0.08	50	51	52	53	54	55	56	57	57	57	58	59
0.09	56	58	59	60	61	62	63	64	64	64	65	66
0.10	63	64	65	67	68	69	70	71	71	72	73	74
0.11	69	70	72	73	74	76	77	78	78	79	80	81
0.12	75	77	78	80	81	82	84	85	85	86	87	89
0.13	81	83	85	86	88	89	91	92	93	93	94	96
0.14	88	90	91	93	95	96	98	99	100	100	102	103
0.15	94	96	98	100	101	103	105	106	107	107	109	111
0.16	100	102	104	106	108	110	112	113	114	115	116	118
0.17	106	109	111	113	115	117	119	120	121	122	123	126
0.18	113	115	118	120	122	124	126	127	128	129	131	133
0.19	119	122	124	126	129	131	132	134	135	136	138	140
0.20	125	128	131	133	135	137	139	141	142	143	145	148
0.21	132	134	137	140	142	144	146	148	149	150	152	155
0.22	138	141	144	146	149	151	153	156	157	158	160	163
0.23	144	147	150	153	156	158	160	163	164	165	167	170
0.24	150	154	157	160	162	165	167	170	171	172	174	177
0.25	157	160	163	166	169	172	174	177	178	179	181	185
0.26	163	166	170	173	176	179	181	184	185	186	189	192
0.27	169	173	176	180	183	186	188	191	192	193	196	199

EXPOSURE CLASS 2

HEIGHT ABOVE GRADE(m)	2.6	3.0	3.4	3.8	4.2	4.6	5.0	5.4	5.6	5.8	6.2	6.8
ELA(m²)						FLOW (L/s)						
0.03	13	13	14	14	15	15	15	16	16	16	16	17
0.04	17	18	18	19	20	20	21	21	21	21	22	22
0.05	22	22	23	24	24	25	26	26	26	27	27	28
0.06	26	27	28	29	29	30	31	31	32	32	33	34
0.07	30	31	32	33	34	35	36	37	37	37	38	39
0.08	35	36	37	38	39	40	41	42	42	43	44	45
0.09	39	40	42	43	44	45	46	47	48	48	49	50
0.10	43	45	46	48	49	50	51	52	53	53	55	56
0.11	48	49	51	52	54	55	56	58	58	59	60	62
0.12	52	54	55	57	59	60	62	63	64	64	65	67
0.13	56	58	60	62	64	65	67	68	69	70	71	73
0.14	61	63	65	67	68	70	72	73	74	75	76	78
0.15	65	67	69	71	73	75	77	79	79	80	82	84
0.16	69	72	74	76	78	80	82	84	85	86	87	90
0.17	74	76	79	81	83	85	87	89	90	91	93	95
0.18	78	81	83	86	88	90	92	94	95	96	98	101
0.19	82	85	88	90	93	95	97	100	101	102	104	106
0.20	86	90	92	95	98	100	103	105	106	107	109	112
0.21	91	94	97	100	103	105	108	110	111	112	114	118
0.22	95	99	102	105	108	110	113	115	116	118	120	123
0.23	99	103	106	109	112	115	118	120	122	123	125	129
0.24	104	108	111	114	117	120	123	126	127	128	131	134
0.25	108	112	116	119	122	125	128	131	132	134	136	140
0.26	112	116	120	124	127	130	133	136	138	139	142	146
0.27	117	121	125	129	132	135	138	141	143	144	147	151

(6a, B.C. S. Coast/S. Vanc. Isl. ELA/Air Flow continued)

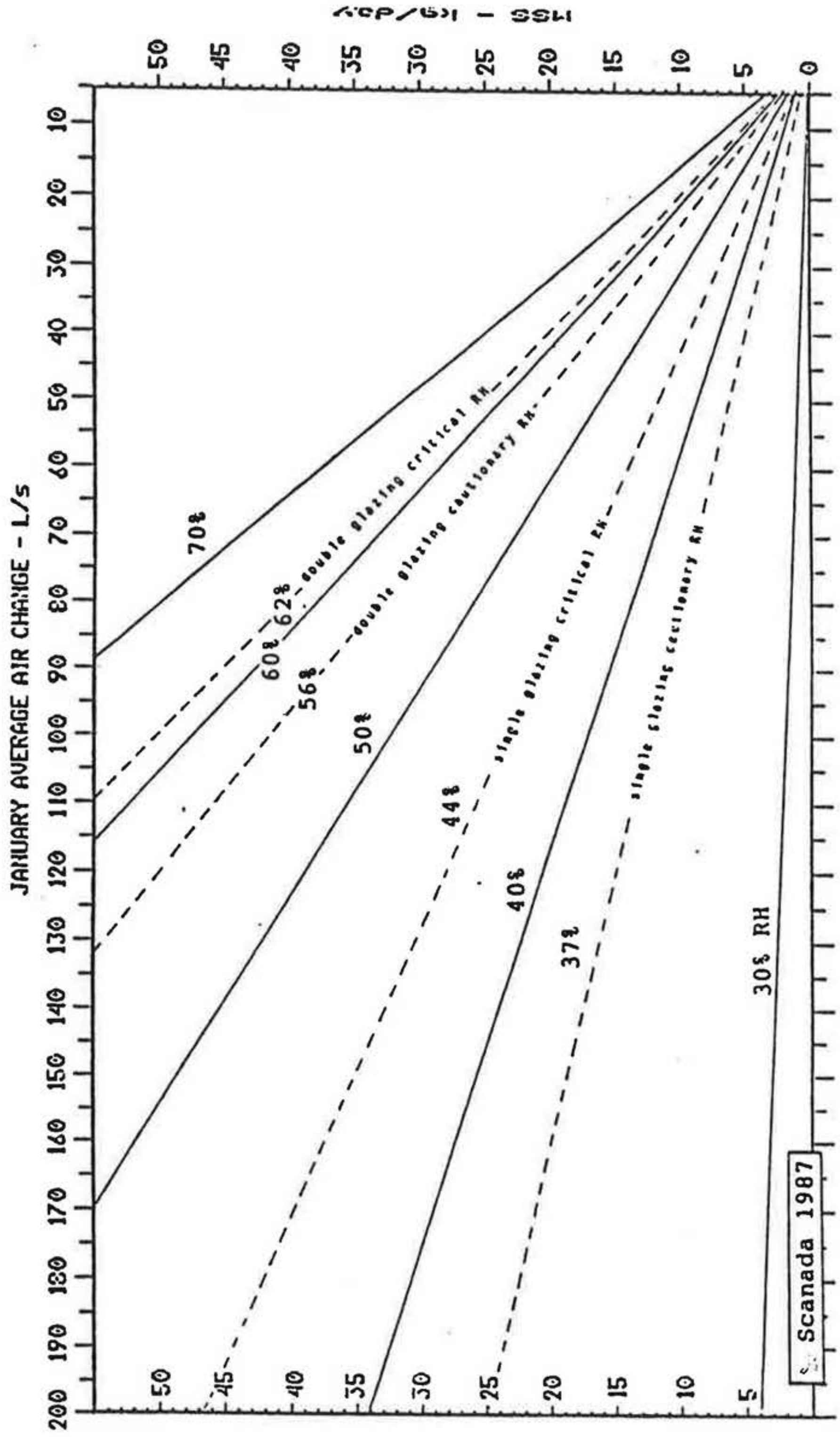
HEIGHT ABOVE GRADE(m)	2.6	BUNGALOW 3.0	3.4	RAISED BUNGALOW 3.8	4.2	4.6	5.0	5.4	2 STOREY 5.6	5.8	6.2	2-1/2 STOREY 6.8
ELA(m^2)						FLOW (L/s)						
0.03	10	11	11	11	12	12	13	13	13	13	14	14
0.04	13	14	15	15	16	16	17	17	17	18	18	19
0.05	17	18	18	19	20	20	21	22	22	22	23	24
0.06	20	21	22	23	24	24	25	26	26	27	27	28
0.07	23	25	26	27	28	28	29	30	31	31	32	33
0.08	27	28	29	30	32	33	34	35	35	35	36	38
0.09	30	32	33	34	35	37	38	39	39	40	41	42
0.10	33	35	37	38	39	41	42	43	44	44	45	47
0.11	37	39	40	42	43	45	46	47	48	49	50	52
0.12	40	42	44	46	47	49	50	52	52	53	54	56
0.13	43	46	48	49	51	53	55	56	57	58	59	61
0.14	47	49	51	53	55	57	59	60	61	62	64	66
0.15	50	53	55	57	59	61	63	65	66	66	68	71
0.16	53	56	59	61	63	65	67	69	70	71	73	75
0.17	57	60	62	65	67	69	71	73	74	75	77	80
0.18	60	63	66	68	71	73	75	78	79	80	82	85
0.19	63	67	69	72	75	77	80	82	83	84	86	89
0.20	67	70	73	76	79	81	84	86	87	89	91	94
0.21	70	74	77	80	83	85	88	91	92	93	95	99
0.22	73	77	80	84	87	90	92	95	96	97	100	103
0.23	77	81	84	87	91	94	96	99	101	102	104	108
0.24	80	84	88	91	95	98	101	104	105	106	109	113
0.25	83	88	91	95	98	102	105	108	109	111	114	118
0.26	87	91	95	99	102	106	109	112	114	115	118	122
0.27	90	95	99	103	106	110	113	116	118	120	123	127

EXPOSURE CLASS 3

HEIGHT ABOVE GRADE(m)	2.6	3.0	3.4	3.8	4.2	4.6	5.0	5.4	5.6	5.8	6.2	6.8
ELA(m^2)						FLOW (L/s)						
0.03	8	8	9	9	10	10	11	11	11	11	12	12
0.04	11	11	12	12	13	14	14	15	15	15	15	16
0.05	13	14	15	16	16	17	18	18	18	19	19	20
0.06	16	17	18	19	20	20	21	22	22	23	23	24
0.07	18	20	21	22	23	24	25	25	26	26	27	28
0.08	21	22	24	25	26	27	28	29	30	30	31	32
0.09	24	25	27	28	29	31	32	33	33	34	35	36
0.10	26	28	30	31	33	34	35	36	37	38	39	40
0.11	29	31	33	34	36	37	39	40	41	41	43	44
0.12	32	34	36	37	39	41	42	44	44	45	46	48
0.13	34	37	39	41	42	44	46	47	48	49	50	52
0.14	37	39	42	44	46	47	49	51	52	53	54	57
0.15	40	42	45	47	49	51	53	55	55	56	58	61
0.16	42	45	47	50	52	54	56	58	59	60	62	65
0.17	45	48	50	53	55	58	60	62	63	64	66	69
0.18	48	51	53	56	59	61	63	66	67	68	70	73
0.19	50	53	56	59	62	64	67	69	70	71	74	77
0.20	53	56	59	62	65	68	70	73	74	75	77	81
0.21	55	59	62	65	68	71	74	76	78	79	81	85
0.22	58	62	65	69	72	75	77	80	81	83	85	89
0.23	61	65	68	72	75	78	81	84	85	86	89	93
0.24	63	67	71	75	78	81	84	87	89	90	93	97
0.25	66	70	74	78	81	85	88	91	92	94	97	101
0.26	69	73	77	81	85	88	91	95	96	98	101	105
0.27	71	76	80	84	88	92	95	98	100	101	105	109

EXPOSURE CLASS 4

6b) B.C. S. Coast/S. Vanc. Isl.: Midwinter Air Flow/MSS/RH



APPENDIX A

to Chapter 5

CASE EXAMPLES SHOWING THE APPLICATION OF THE DETAILED MAPP ROUTINE

Appendix A: to Chapter 5: Case Examples Showing the Application of the Detailed Mapp Routine

1. Assessing moisture generation

This procedure first appears somewhat tedious, and is therefore moved ahead of air-flow assessment in these examples. With very little practice it becomes easy and quick to use. Either Figure 1 (repeated overleaf from Chapter 5) or the One-Page MAPP's left hand scales can be used for the occupancy; Table 2 of Chapter 5 is used for the below-grade moisture.

1.1 Moisture from occupancy

Example 1: If a house has 4 occupants and most are away during the day, find the moisture generation rate due to occupancy if the house is equipped with an automatic dryer ,vented outdoors, and a bathroom exhaust fan which is used during all bathing and showering.

1. **On Figure 1, connect the appropriate occupant numbers (4) on the high and low scale of moisture generation to form a "range line", and divide it into quarters.**

2. **Since the dryer is vented, move the reference point 3/4 of the way down the range line. (Point A)**

3. **Since the bathroom has an exhaust fan in full use, move the reference point a further 1/8 down the line so that it is midway down the last quarter. (Point B)**

4. **Since most of the people are absent during the day, and no excessive amounts of moisture are being generated, the last position of the reference point represents the moisture being generated by the occupants. Extend the line horizontally to find the moisture rate as shown. (i.e. 15 kg/day).**

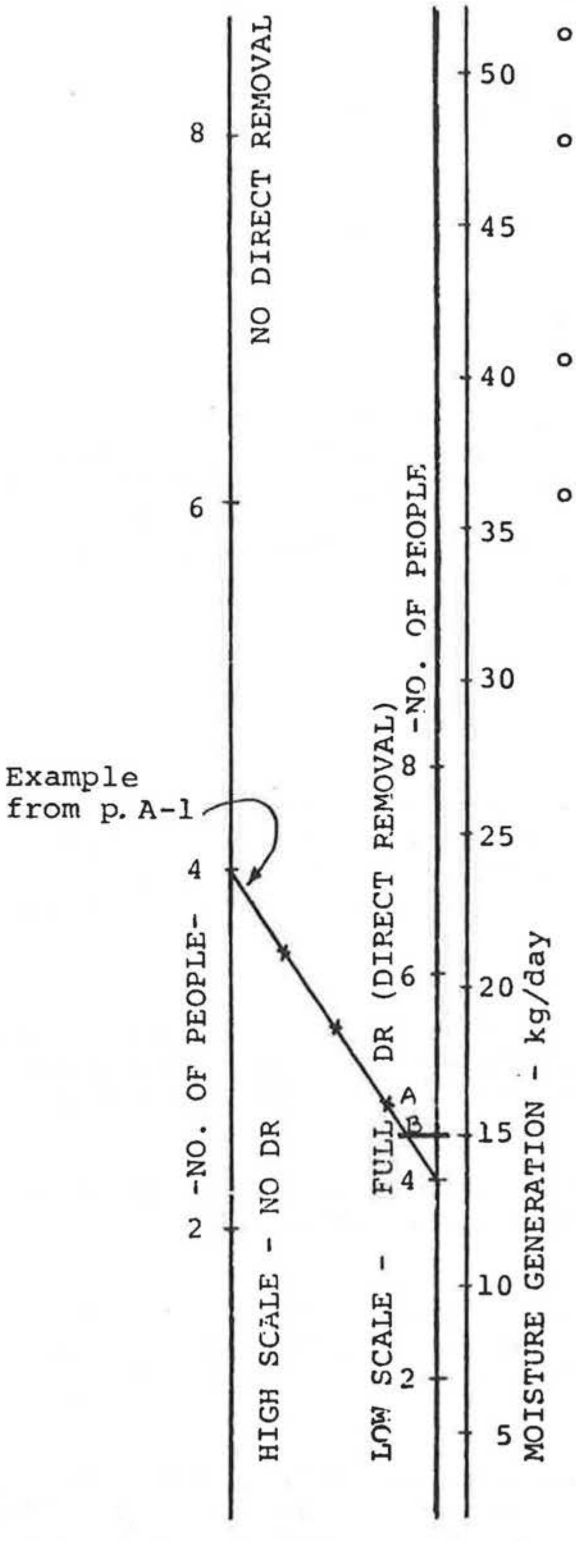


FIGURE 1 SPLIT SCALE, MOISTURE GENERATION (repeated from Chap. 5)

- Mark the number of occupants on the "No DR" scale, indicating the top of the probable range.
- Do likewise on the Full DR scale, marking the extreme bottom of the range. In Figure 1, the example of four occupants is marked. Hours at home are disregarded: overnight occupancy is all that matters at this point.
- Draw a straight line between the two marks, forming a "range line" as shown. Mark its quarter and half points.
- Judge the actual level on the range line:
  - If the clothes dryer is always vented in winter, set the level first at the point three quarters of the way down the range line.
  - However, if the clothes dryer is not vented the level should first be set at the top of the range line.
  - If both kitchen and bath are provided with fans <u>and these are always used when cooking or bathing/showering in winter</u>, adjust the level downward from its beginning position by an amount equal to one quarter of the length of the range line.
  - However, if there is little or no such DR, the MSS level may be left where it was first placed. If only one such fan is installed and used rigorously, or if the fans are used just "most of the time", the level may be adjusted downward, from its first position, by one eighth the length of the range line.
  - Finally, if most of the occupants are at home day and night, and/or have hobbies, work or cooking habits often generating water vapour, the level may be adjusted upward by a distance of one quarter of the range line. This last adjustment holds true even if the final position ends up above the top of the range line.

The MSS from occupancy is indicated on the MSS scale horizontally across from the final point.

1.2 Moisture from below grade

Example 2: An unfinished basement, heated in winter and having a plan area of 150 m^2, has fairly widespread damp spots and broad areas of water seepage in fall and even occasionally in winter. It also has considerable patches of efflorescence. Find the moisture contribution rate due to soil contact. If this basement applied to the previous example, find the total moisture generation rate.

1. From Table 1, the best fit for the observed moisture signs appears to be in the "substantial" column. This suggests a moisture contribution rate of 20 kg/day/100 m^2.

2. Soil moisture contribution for 150 m^2 basement is
   150/100 x 20 = 30 kg/day

3. Total moisture generation = 15 (from Figure 1, occupancy) + 30 = 45 kg/day

2. Assessing air flow and then the midwinter RH of the existing house

Either the ELA/air flow tables can be used to enter the One-Page MAPP, or the latter can be used by itself (The example is traced on the One-Page MAPP that follows next.)

Example 3: A bungalow in suburban St. Johns has an ELA of 0.140 m^2. It has a 143 m^2 unfinished but heated basement with a bare concrete floor. The basement seems dry except for occasional patches of efflorescence, and has a musty odour even in winter. The house has a dryer (vented outdoors) and exhaust fans in the kitchen and bathroom, which are used whenever moisture is generated. The house has a flue serving an oil furnace. The house is occupied by 6 persons most of whom are away during the day. Cooking and other activities that generate moisture are considered average. Estimate the midwinter RH.

1. The house, being in a suburban development is assumed to have an exposure class of 4.

2. Locate and enter the first position in Figure 2 on the class 4 bungalow scale, ELA = 0.140 m^2, as position (1). (Of course, if it were class 2 the location would be pinpointed on the top horizontal scale; if class 3, it would be judged halfway between the class 4 and class 2 positions.)

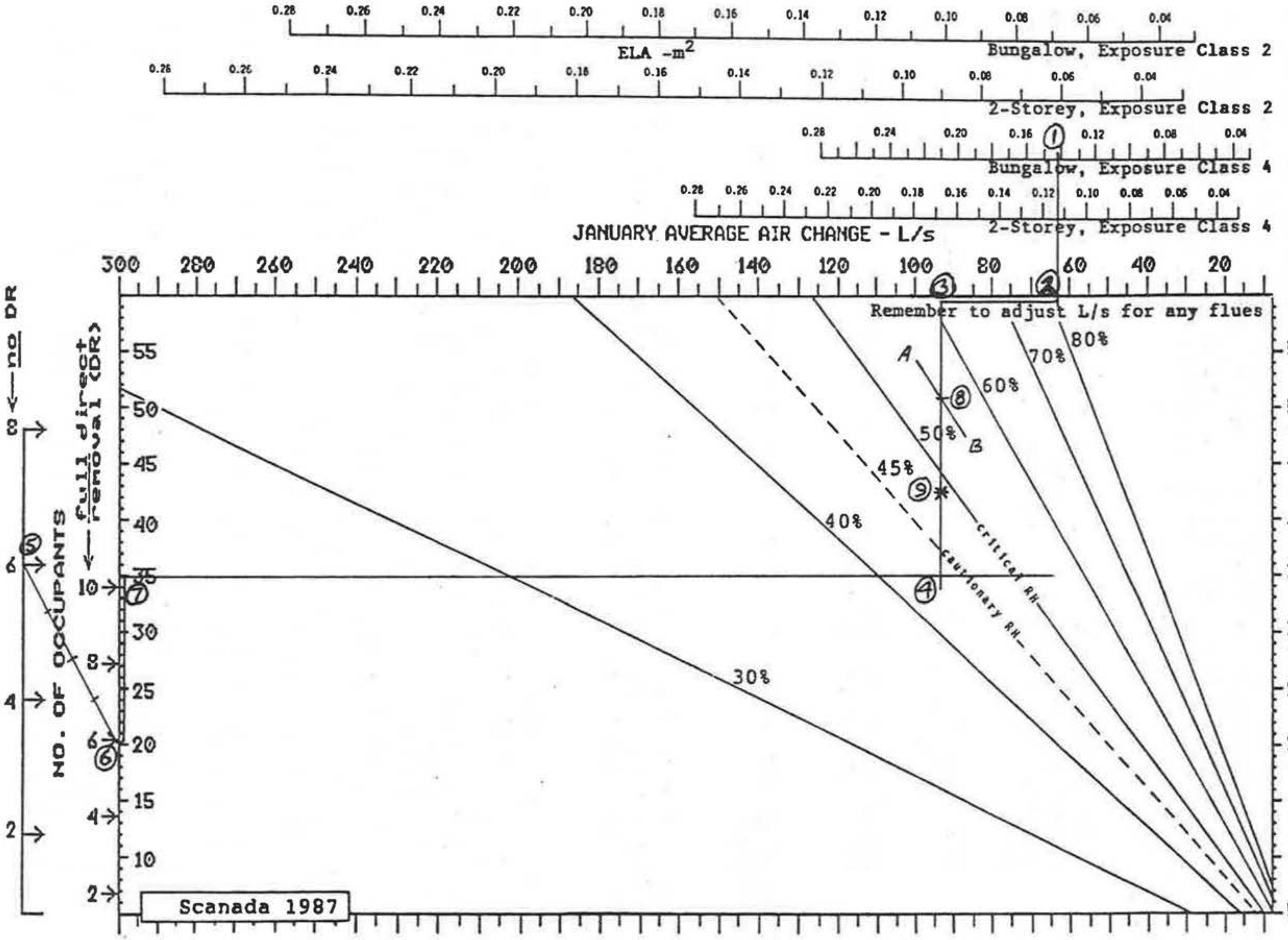


Figure 2 - ASSESSING A ST. JOHN'S HOUSE ON THE ONE-PAGE MAPP (example 3 in text)

3. Draw a vertical line from (1) to intersect the ventilation rate scale at (2).

4. To this indicated ventilation rate (62 L/S) is added an allowance for the flue (30 L/S) to reach point (3).

5. A vertical line is drawn from (3), indicating the total ventilation rate.

6. A moisture rate "range line" (5)-(6) is drawn on the left hand scale to show the high and low range for an occupant load of 6 people and is divided into quarters.

7. Since the dryer is vented outside, the reference point for the moisture generation rate is brought 3/4 down this range line.

8. Since the kitchen and bathroom both have exhaust fans in full use, the reference point is moved an additional 1/4 down the line to (6). (If only one were present and in use, the downward adjustment would have been 1/8.)

9. Since there are no additional moisture causing activities of an exceptional nature, (6) indicates the total moisture rate due to occupancy.

10. The basement moisture contribution is suggested by Table 2 as 10 kg/100 m^2/day. For a 143 m^2 basement this is 143/100 x 10 or 14.3 kg/day.

11. This value is added to location (6) to reach point (7) which represents the total rate of moisture generation.

12. A horizontal line is drawn from (7) to intersect the vertical line from (3). This intersection, (4), locates the estimated RH (i.e. 43%).

13. Line AB is drawn to represent the RH determined from recollected window condensation based on Table 4 (assumed here as 55%), intersecting line (3) (4) at point (8).

14. Since this RH level is above the first value shown as point (4), it must be used to adjust the latter.

15. The adjusted RH is half way between (4) and (8) at point (9) (i.e. 48%).

3. Predicting and avoiding problems in the house if energy-retrofit were done

Example 4: The house in Example 3 is operating above the cautionary RH level (Figure 2). Planned renovation includes insulating the ceiling and sealing obvious air leaks into the attic. The basement walls are to be strapped and insulated, following which a recreation room (about 1/3 of the basement) will be built with finished walls and tiled floor. One of the children will soon be leaving to live elsewhere. Find the effect on RH. While these steps could be entered on Figure 2, they are traced here for clarity on a fresh MAPP chart, Figure 3.

1. The insulation of the basement walls and the normal procedures of caulking around penetrations is assumed to reduce the envelope leakage by 10% (Table 4). The insulation and sealing is also assumed to reduce the air leakage by 10%.

2. The air leakage in Example 2 through the envelope was found to be 62 L/S (point (2)). Therefore the new air leakage must be adjusted to 0.9 x 0.9 x 62 or 50 L/S, entered as point (2) in Figure 3.

3. The effect of the flue is unchanged and this (30 L/S) must be added to find the new total leakage at (3). (80 L/S, Figure 3).

4. A vertical line is drawn through (3) as before.

5. Since the occupant load has dropped to 5, a new range line for moisture rate is drawn as line (5) (6) and again divided into quarters.

6. Direct moisture removal by dryer venting and bathroom and kitchen exhaust fans is unchanged so that the estimated moisture rate is at the bottom of the range at point (6).

7. The basement moisture assumed in Example 3 was 14.3 kg/day (Table 2), but the insulation of the basement walls and the partial finishing of the floor and walls for the recreation room is assumed to be 50% effective. The adjusted moisture contribution of the basement is therefore 0.5 x 14.3 = 7.2 kg/day.

8. The basement moisture rate is added to that due to the adjusted occupancy of 5 persons (17 kg/day, figure 3) to reach the total moisture generation rate of 24 kg/day at point (7).

9. A horizontal line from (7) is drawn to intersect the vertical line through (3) at point (4) (39% RH).

10. Since the RH calculation in Example 3 (figure 2) had to be adjusted upward 5 percentage points, as a correction in recognition of recollected window condensation, the same upward adjustment may be made at this point. The estimated RH due to retrofit and household changes is therefore 39 + 5, or 44%, which is below the cautionary level.

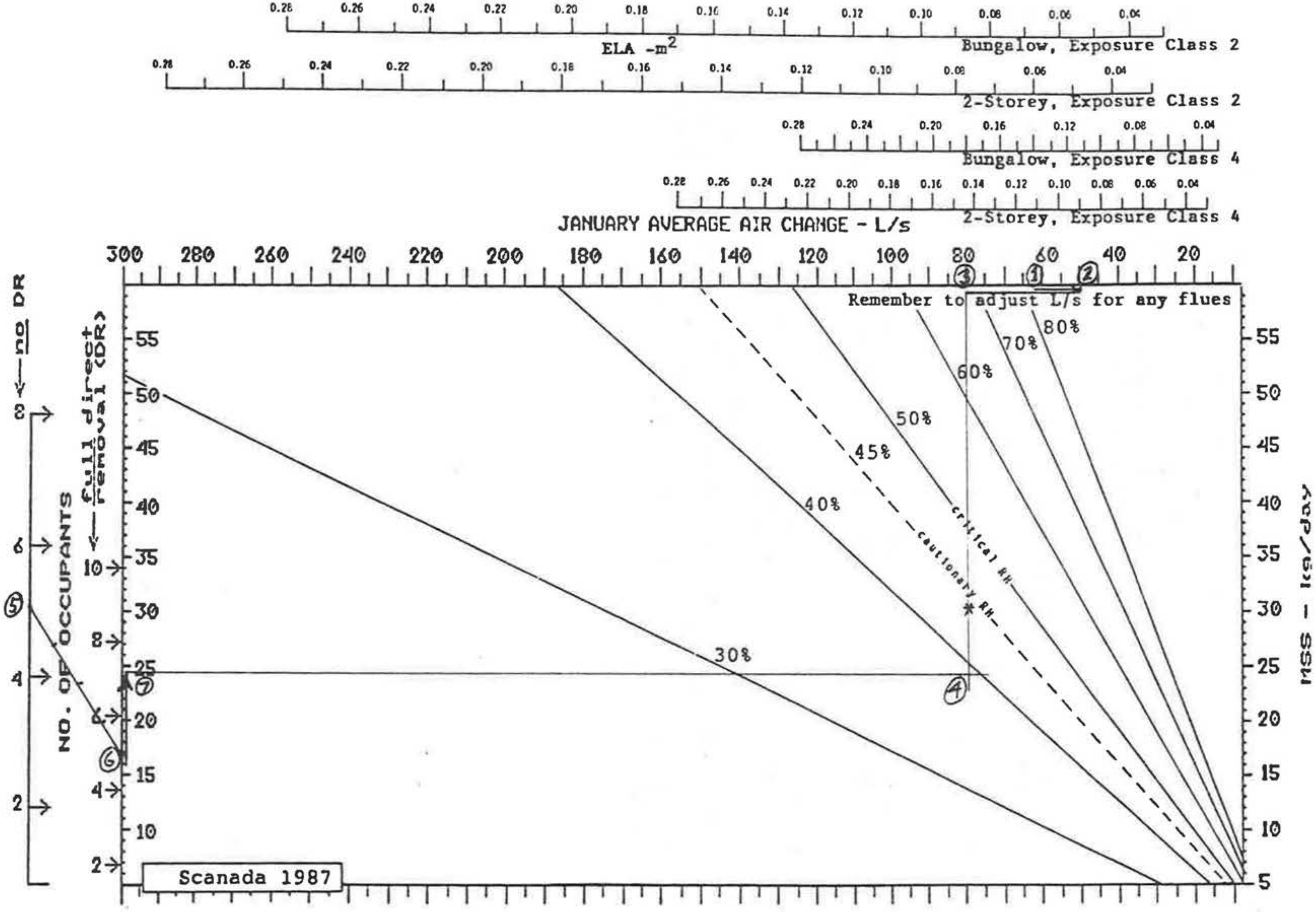


Figure 3 - RE-ASSESSING EXAMPLE TO PREDICT THE EFFECT OF RETROFITS (and occupancy change)